(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 947 328 B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
07.12.2005 Bulletin 2005/49

(51) Int Cl.[7]: **B41J 2/175**

(21) Application number: **99302481.9**

(22) Date of filing: **30.03.1999**

(54) **Ink cartridge and remaining ink volume detection method**

Tintenpatrone und Verfahren zur Detektion der restlichen Tintenmenge

Cartouche d'encre et procédé de détection du volume d'encre restant

(84) Designated Contracting States:
DE GB SE

(30) Priority: **30.03.1998 JP 8403798**
07.04.1998 JP 9477298
07.04.1998 JP 9477398
07.04.1998 JP 9477498
07.04.1998 JP 9477598
07.04.1998 JP 9477698
07.04.1998 JP 9477798
07.04.1998 JP 9477898
28.05.1998 JP 14699398
15.06.1998 JP 16692098
05.02.1999 JP 2832099

(43) Date of publication of application:
06.10.1999 Bulletin 1999/40

(60) Divisional application:
02029048.2 / 1 300 248
02029049.0 / 1 300 249

(73) Proprietor: **Brother Kogyo Kabushiki Kaisha**
Nagoya-shi, Aichi-ken 467-8561 (JP)

(72) Inventor: **Sasaki, Toyonori**
Anjou-shi, Aichi-ken (JP)

(74) Representative: **Senior, Alan Murray**
J.A. KEMP & CO.,
14 South Square,
Gray's Inn
London WC1R 5JJ (GB)

(56) References cited:
EP-A- 0 573 274
EP-A- 0 631 874
EP-A- 0 685 340
EP-A- 0 765 756
EP-A- 0 791 464
US-A- 5 703 633

EP 0 947 328 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates to an ink cartridge for holding ink that is supplied to a recording head, that is removably attached to recording heads used in image forming apparatuses, and to an ink volume detection method for the ink cartridge.

[0002] Image forming apparatuses such as ink jet printers eject ink droplets from nozzles in a recording head mounted on a carriage, thereby recording images on recording media. The ejection of the ink droplets is accomplished by driving actuators such as electric-to-mechanical converter elements or electric-to-thermal converter elements positioned inside the recording head to generate pressure waves. The ink is supplied from an ink cartridge mounted on the recording head so that it can be easily removed and replaced. When air bubbles are mixed in with the ink liquid that is supplied from the ink cartridge, however, this has an adverse effect on the ejection of ink from the nozzles in the recording head.

[0003] In Fig. 20 is diagrammed an example of an ink cartridge structure as disclosed in Japanese Patent Application Laid-Open No. H9-70982/1997. An ink cartridge 150 has an ink supply hole 153 for supplying ink to a recording head 137, and an atmosphere connection hole 155 communicating to the outside atmosphere so as to allow air to flow in from outside the cartridge 150 as the ink volume is diminished by the consumption of ink absorbed in a porous material 152. Accordingly, after the ink cartridge 150 is filled with ink during fabrication, both of these openings (i.e. the ink supply hole 153 and atmosphere connection hole 155) are closed off by a sealing material. Also, as disclosed in Japanese Patent Application Laid-Open No. H7-132611/1995 (gazette), for example, at the time of shipment from the factory, the ink cartridge containing ink is sealed in a reduced-pressure condition inside a packaging bag to prevent ink leakage and the intrusion of air into the case prior to cartridge use. When it is time for use, the user removes the ink cartridge from the packaging bag, peels away the sealing material, thereby opening the atmosphere connection hole, and connects the ink supply hole to the recording head.

[0004] It is desirable to have the ink supply hole and the atmosphere connection hole located some distance apart in order both to prevent air from being drawn from the atmosphere connection hole into the ink supply hole via a short circuit and to facilitate use of the ink contained in the case without waste. For this reason, the ink supply hole and atmosphere connection hole are located on mutually opposing sides of the case, as diagrammed in Fig. 20. When filling the ink cartridge 150 with ink during the manufacturing process, on the other hand, the ink supply hole 153 serves also as the ink filling hole, and the atmosphere connection hole 155 is used as a pressure-reduction hole in order to reduce the pressure inside the case. Thus ink is filled in through the ink supply hole while effecting reduced pressure inside the case.

[0005] In the process of filling the ink cartridge 150 with ink, it is necessary to bring an ink filling apparatus and a pressure reduction apparatus up against both sides (the right side and left side in Fig. 20) of the ink cartridge 150. After the ink filling operation, sealing tape has been used to seal the ink supply hole 153 and the atmosphere connection hole 155. However, in the case of a cartridge structure such as that diagrammed in Fig. 20, the sealing tape must be pulled all the way around the case, from the upper surface (right side surface in Fig. 20) to the lower surface (left side surface in Fig. 20). Not only does this require a long length of tape, but, when the sealing tape is applied using a roller mechanism, the operation cannot be accomplished from one side of the case, so the sealing tape must be pulled around the case from the upper surface to the lower surface while rotating the case, thus involving an inefficient operation.

[0006] After sealing the ink filling hole (ink supply hole) with the sealing tape, the sealing tape has been heat welded by the application of heat. If the ink filling hole is wet with ink, however, heat welding cannot be adequately performed. When more heat is applied to avoid this, a problem arises in that the ink supply hole is deformed so that it cannot be properly connected to the recording head.

[0007] During the ink filling operation, moreover, when the interior of the case is placed under reduced pressure by the pressure reduction apparatus, the entire case is sometimes deformed, whereupon the case cannot be efficiently filled with ink.

[0008] When the configuration is such that a porous material 152 is accommodated inside the cartridge case to absorb the ink, as diagrammed in Fig. 20, it is demanded that the filling be done efficiently so that the ink reaches to the corners inside the porous material 152.

[0009] It is also demanded that, when the ink cartridge is being replaced, the user can easily peel away the sealing tape and efficiently utilize the ink in the case.

[0010] With this type of ink cartridge, furthermore, the remaining ink volume is continually or periodically detected by a detector installed in the recording apparatus. When it is detected that the remaining ink volume is low, the recording apparatus advises the user to replace the ink cartridge. This detection of the remaining ink quantity inside the ink cartridge is generally performed by detecting the ink liquid level. However, because the liquid level tends to shake and fluctuate because the ink cartridge is mounted on a carriage that moves in a sweeping motion in the width direction of the recording medium, erroneous detections often to occur. That being so, one measure known in the prior art for reducing the liquid level fluctuations (shaking) is that of providing rib-shaped members inside the cartridge case. This measure, however, requires the case structure to be complex. Also known is the method of directing light onto the po-

rous material absorbing the ink inside the case and detecting the remaining ink quantity from the light reflected back. With this method, however, it is difficult to detect the remaining ink quantity accurately because the presence or absence of ink in the porous material differs from location to location therein.

[0011] In an ink jet type of image forming apparatus, in order to restore the ink ejection function, a suction cap connected to a suction pump is used to cover the recording head and suck out large amounts of ink from the recording head. When the ink liquid level inside the ink cartridge falls rapidly due to this suction, not all of the ink in contact with the wall surfaces of the ink cartridge moves instantly to the same height position, more or less, as the ink liquid level. Some of this ink remains adhering to the wall surfaces. This phenomenon becomes increasingly pronounced as the distance from the corners of the outer walls of the ink cartridge (i.e. the ridges thereof) increases, that is, the closer the center of the flat wall surfaces is approached. Accordingly, in cases where the detection site for a sensor is located near the center of the cartridge wall surface, even when the ink liquid level falls, so that there is little actual remaining ink quantity, that fact cannot be detected, wherefore erroneous detections occur, which is a problem.

[0012] When the remaining ink quantity inside the ink cartridge is being detected with a sensor, particularly one that is of the reflected light type, in order to accurately eject light onto a detection site from a light emitting element, and have the light reflected at the inner surface of the outer wall of the ink cartridge that is the detection site received without fail by a light receiving element, the positions of the light emitting element and light receiving element relative to the detection site must be accurately established. However, the ink cartridge is made so that it can be freely attached to and detached from the recording head so that the user can replace it. The condition in which the ink cartridge is mounted will be slightly different, therefore, every time the user replaces it. In some cases, moreover, variation in the positions in which the reflected light sensors are attached relative to the carriage will arise at the stage of recording apparatus manufacture. Thus, when there are slight irregularities in the distance between the reflected light sensor and the detection site, or in the attachment position or angle of the reflected light sensor relative to the detection site, the light receiving element cannot properly detect the reflected light, so that the remaining ink quantity inside the ink cartridge cannot be detected or the remaining ink quantity detection precision sharply declines.

[0013] With this type of ink cartridge, furthermore, ink sometimes travels along the inner walls of the ink chamber holding the ink and reaches the atmosphere connection chamber adjacent to the ink chamber. This ink sometimes also passes through the atmosphere connection hole and leaks to the outside. If the case is transparent or semi-transparent, the case will become unsightly once ink penetrates into the atmosphere connection chamber. If the ink plugs up the atmosphere connection hole, that will impair the supply of ink to the recording head.

[0014] A type of ink cartridge is also known wherein, inside the ink cartridge case, a first chamber is provided for accommodating the porous material absorbing ink, and a second chamber is provided downstream from the first chamber, such that ink is supplied to the recording head via an ink supply hole from the second chamber, see e.g. EP-A-0 791 464. With such a structure as this, when air bubbles intrude into the second chamber from the first chamber, and those air bubbles are drawn to the recording head from the second chamber, there is a danger that the recording head will become incapable of ink ejection due to the air bubbles.

[0015] In a vacuum pack such as is described in the foregoing, furthermore, in order to maintain the interior thereof at reduced pressure for extended periods of time, it is necessary that there be space between the ink cartridge and the packaging bag of the pack, which space has a higher degree of vacuum than the interior of the ink cartridge. Supposing that a substantially rectangular ink cartridge is contained in a packaging bag, and that the packaging bag adheres tightly to the cartridge, outside air that gradually penetrates through the packaging bag will relatively quickly fill the slight gap between the packaging bag and the ink cartridge, making it difficult to maintain the reduced pressure condition for any extended period of time. Japanese Patent Application Laid-Open No. H10-250111/1998 discloses a cartridge wherein, in order to secure a prescribed volume for the reduced pressure space, the exterior shape is not made a simple rectangle but rather is made so that a part thereof projects, thus forming a space alongside the projecting part where the packaging bag does not tightly adhere. With this cartridge, holes are sometimes opened in the packaging bag by the cartridge corners. In Japanese Patent Application Laid-Open No. 7-132611, art is disclosed for inserting other components (spacers) inside the packaging bag such as corrugated cardboard or urethane foam which contain air internally and through which air readily passes. When separate components are inserted inside the packaging bag, however, the number of manufacturing processes increases, costs rise, and the exterior shape of the packaging bag becomes large, which is undesirable in the interest of smaller size.

[0016] EP-A-0 573 274 describes an ink-detecting device which is used for a recording apparatus which records on a recording medium by use of a plurality of recording means for recording on the recording medium while being shifted correlatively with respect to the recording medium corresponding to a plurality of different colours of ink, which is capable of detecting the amount of ink in a plurality of ink-reservoiring means shiftable together with the recording means correlatively with re-

spect to the recording medium. The detecting device comprises a transparent member provided for the wall of each of the ink-reservoiring means; light-emitting means for emitting light provided in a given position along the shifting passage of the ink-reservoiring means in order to emit light to the transparent member arriving at the given position; light-receiving means for receiving the light which is emitted from the light-emitting means and totally reflected at least once on the inner surface of the transparent member in ink-reservoiring means wherein the light emitted from the light-emitting means to said transparent member reaches the light-receiving means when totally reflected at least once on the inner surface of the ink-reservoiring means which is not in contact with the ink, and is transmitted without any total reflection through the inner surface of the ink-reservoiring means which is in contact with the ink; and detecting means for detecting per ink-reservoiring means whether the light- receiving means has received the light or not when the plural ink-reservoiring means arrive at the given position.

SUMMARY OF THE INVENTION

[0017] The present invention has been devised for the purpose of resolving the problems with the prior art described in the foregoing. A first object thereof is to provide an ink cartridge wherewith bringing a filling apparatus and a pressure reduction apparatus close to the cartridge package for ink filling is rendered easy, and the operation of applying seals to the case openings is made simple.

[0018] A second object of the present invention is to provide an ink cartridge wherewith the case can be efficiently filled with ink all the way to the corners thereof, wherewith case deformation due to reduced pressure during filling is prevented, and wherewith filling can be done even more efficiently.

[0019] A third object of the present invention is to provide an ink cartridge that is made so that the remaining ink quantity can be detected utilizing the space that is for filling the case with ink, which suppresses ink liquid level fluctuation even though the case has a simple structure, and wherewith the remaining ink quantity can be detected accurately.

[0020] A fourth object of the present invention is to provide an ink cartridge wherewith, even when the liquid level fluctuates rapidly due to ink being drawn out from the recording head, and even when there is variation in the position where the sensor is attached in the recording apparatus, accurate remaining ink quantity detection is made possible.

[0021] A fifth object of the present invention is to provide an ink cartridge wherein the intrusion of ink to the atmosphere connection hole side from the ink chamber is prevented, and wherein, even when there is a slight occurrence of such ink intrusion, leakage to the outside and blocking of the atmosphere connection hole is prevented.

[0022] A sixth object of the present invention is to provide an ink cartridge wherewith, when ink is being supplied successively from a first chamber to a second chamber in an ink chamber, air bubbles are not drawn directly into the recording head even when air bubbles intrude into the second chamber, and wherewith ink ejection problems caused by air bubbles are prevented.

[0023] A seventh object of the present invention is to provide an ink cartridge wherewith the inside of the packaging bag used to hermetically seal the ink cartridge is maintained at reduced pressure for an extended period of time, wherewith there is no particular need for any separate component for forming space for that purpose, and wherewith manufacturing costs can be reduced and achieving smaller size is rendered easy.

[0024] An eighth object of the present invention is to provide a remaining ink quantity detection method wherewith the remaining ink quantity inside the ink cartridge can be accurately detected.

[0025] According to the present invention, an ink cartridge is provided which is removably attached to a recording head and which holds ink supplied to the recording head, comprising: a case having a first surface and a second surface in opposition, both surfaces whereof are open, a partitioning wall for separating the interior of the case into an ink chamber for holding ink and an atmosphere connection path communicating to the outside of the case, wherein the ink chamber is open on the first surface and the second surface sides, a first cover for covering the first surface of the case so that a path is formed for communicating between the ink chamber and the atmosphere connection path, a second cover for covering the second surface of the case, and an ink supply hole that connects to the recording head, formed in the second cover so as to communicate with the ink chamber.

[0026] With an ink cartridge implemented according to the present invention, the opposing first and second surfaces of the case are open, respectively, wherefore it is easy to form the ink chamber and the atmosphere connection path inside the case. It is necessary to wash the inside of the case beforehand so that the ink characteristics do not change. Both surfaces are open in this cartridge, making washing and drying convenient. Also, assembly is rendered simple by covering the first and second surfaces, respectively, with the first cover and the second cover. The cartridge may have a second partitioning wall for dividing the ink chamber into a first chamber for accommodating the porous material absorbing ink and a second chamber for accommodating ink. One of the chambers, i.e. the first chamber or the second chamber, may be covered by the first cover while the other chamber is covered by the second cover. In that case, in this type of ink cartridge, the first chamber may communicate with the atmosphere connection path near the first surface and also communicate with the second chamber near the second surface, while the

second chamber communicates with the ink supply hole. Based on this aspect, during a recording operation, ink is supplied to the recording head under a suitable pressure from the ink supply hole via the second chamber by the suction force of the porous material in the first chamber. When ink in the second chamber flows out from the ink supply hole, ink is replenished in the second chamber from the porous material in the first chamber while air is taken into the first chamber from the atmosphere connection path. As a result, after the first chamber ink is consumed, the second chamber ink is consumed, whereupon all the ink is used effectively.

[0027] According to the present invention, an ink cartridge is provided which is removably attached to a recording head and which holds ink supplied to the recording head, comprising: a cartridge case having a mutually opposed first side wall and second side wall, a first partitioning wall positioned substantially parallel to the first side wall of the case so as to separate the interior of the cartridge case into a first chamber and a second chamber, respectively, for accommodating ink, and a second partitioning wall positioned substantially parallel to the first side wall of the case for separating the interior of the case into a first chamber and an atmosphere connection path for communicating with the atmosphere outside the case, wherein one end of the second chamber communicates with one end of the first chamber, the other end of the second chamber is open the outside of the case as an ink supply hole, one end of the atmosphere connection path communicates with the other end of the first chamber, and the other end of the atmosphere connection path is open to the outside of the case.

[0028] With an ink cartridge implemented according to the present invention, a second partitioning panel (or a first partitioning panel) is placed substantially parallel to a first side wall, wherefore the side wall becomes a two-ply structure so that the strength of the cartridge is increased. For this reason, when the cartridge is being filled with ink, the cartridge is prevented from deforming, even when the interior thereof is under reduced pressure, and ink filling can be accomplished efficiently.

[0029] In the cartridge, the atmosphere connection path may be demarcated between the first side wall and the second partitioning wall, and the second chamber demarcated between the second side wall and the first partitioning wall. Also, an ink supply hole for supplying ink to the recording head may be provided near the one end of the second chamber and the ink in the first chamber supplied to the recording head from the ink supply hole via the second chamber. Given this structure, the cartridge is arranged so that the ink supply hole is normally positioned below, wherefore, even should air bubbles flow into the second chamber from the first chamber together with the ink, air bubbles are prevented from floating up toward the top of the second chamber and being drawn into the ink supply hole. For this reason, ink discharge failure from the recording head can be prevented. In a cartridge based on the fifth aspect, the other end of the first chamber may be open, the open part covered by the first cover, the one end of the second chamber open, the open portion covered by the second cover, and the ink supply hole formed in the second cover. With this cartridge, a case can be used which is open on both sides and easily formed, and a cartridge can be easily manufactured by adding a first and a second cover to this case.

[0030] In the cartridge, furthermore, a third partitioning wall may be provided which extends substantially perpendicular to the first side wall inside the case and connects the lower ends of the first partitioning wall and the second partitioning wall, the first chamber divided by the first, second, and third partitioning walls, and a connecting hole formed in the third partitioning wall to connect between the first and second chambers. In this case, one end of the first chamber may be open, the open portion covered by the first cover, the ink filling hole connecting the second chamber and the outside of the case formed in the first cover, one end of the second chamber open, the open portion covered by the second cover, and an atmosphere connection hole communicating with the atmosphere connection path formed in the second cover.

[0031] According to the present invention, an ink cartridge is provided which is removably attached to a recording head and which holds ink supplied to the recording head, comprising: a cartridge case having an upper case surface and a lower case surface, a partitioning wall for dividing the inside of the case into first and second chambers for accommodating ink, respectively, wherein the first and second chambers mutually communicate near the lower case surface, an ink filling hole for filling the second chamber with ink, formed in the upper case surface, a sealing material for closing off the ink filling hole, an ink supply hole for supplying ink to the recording head from the second chamber, formed in the lower case surface, and an atmosphere connection hole for connecting the first chamber to the atmosphere, wherein the second chamber is formed between one side wall of the case and the partitioning wall, and at least one portion of the one side wall is either transparent or semi-transparent.

[0032] In the cartridge, when the ink is supplied to the recording head from the ink supply hole of the ink cartridge, ink is supplied from the first chamber to the second chamber, whereupon the first chamber ink decreases in volume first. When the first chamber ink is depleted, air flows into the second chamber and the second chamber ink decreases in volume. Hence the remaining ink quantity can be known by detecting a fall in the ink liquid level in the second chamber, either visually or with a sensor. Also, ink is filled from the second chamber via the ink filling hole, and the filling hole is closed off with a sealing material after the second chamber and the first chamber have been filled, wherefore the second chamber can be completely filled. Thus erroneous detections of the initial remaining ink quantity can be prevented.

[0033] In the cartridge, the first chamber may be given a larger capacity than the second chamber and made to accommodate the porous material absorbing ink. Even when a large volume of ink is present in the first chamber, due to the suction force of the porous material, ink can be supplied to the recording head from the ink supply hole under suitable pressure. Also, by detecting the remaining ink quantity in the second chamber of smaller capacity, erroneous detections caused by ink wave formation can be prevented. In this case, the upper case surface may be configured with a cover attached to the case, and the ink filling hole formed in the cover. When this is done, the structure of the ink cartridge becomes simple. If a sheet material is used as the sealing material, this can be easily applied to the cover so as to close off the ink filling hole.

[0034] In the cartridge, the inner surface of the transparent or semi-transparent portion of the one side wall may have undulating ribs running vertically up and down.

[0035] Based on this configuration, when, for example, a remaining ink quantity sensor is used that comprises a light emitting component and a light receiving component, the light emitted by the light emitting component is reflected at the inner surface of the side wall of the second chamber, whereupon it is scattered by the undulating ribs on that inner surface in directions perpendicular to the undulating ribs, and the reflected light advances toward the light receiving component while spreading out in a plane that includes the light emitting component, the light receiving component, and the detection site on the main case body. Therefore, even in cases where the interval between the detection site and the sensor has slightly changed due to slight differences in the ink cartridge mounting position or sensor attachment position, the light receiving component can safely capture the reflected light. Accordingly, the remaining ink quantity inside the ink cartridge can be unambiguously detected even when there is some degree of variation in the sensor attachment condition or ink cartridge mounting condition.

[0036] The present invention will be more clearly understood from the following description, given by way of example only, with reference to the accompanying drawings in which:

Fig. 1 is a cross-sectional view depicting an ink cartridge according to a first embodiment of the present invention mounted on a recording head;
Fig. 2 is an external view of the ink cartridge;
Fig. 3 is a cross-sectional view of the ink cartridge;
Fig. 4 is an exploded cross-sectional view of the ink cartridge;
Fig. 5 is a cross-sectional view in the B-B plane of Fig. 1;
Fig. 6 is a bottom view of a case with the lower cover member of the ink cartridge removed;
Fig. 7 is a top view of the ink cartridge before applying the upper cover member seal;
Fig. 8 is a top view of the ink cartridge after applying the upper cover member seal;
Fig. 9 is a bottom view of the ink cartridge;
Fig. 10 is a cross-sectional view in the A-A plane;
Fig. 11 is an enlarged diagonal view of the configuration of the path 16b between the first chamber and the atmosphere connection path;
Fig. 12 is an enlarged diagonal view of an improved configuration for the connecting part in Fig. 11;
Fig. 13 is an enlarged diagonal view of a further improved configuration for the connecting part in Fig. 11;
Fig. 14 is a side elevation of the ink cartridge;
Fig. 15 is a horizontal cross-sectional view that conceptually diagrams the way light is reflected at the remaining ink quantity detection site;
Fig. 16 is a horizontal cross-sectional view that conceptually diagrams the way light is reflected at the remaining ink quantity detection site;
Fig. 17 is a vertical cross-sectional view that conceptually diagrams the way light is reflected at the remaining ink quantity detection site;
Fig. 18 is a diagram for explaining the ink cartridge ink filling operation;
Fig. 19 is a cross-sectional view of the ink cartridge when accommodated in a packaging bag; and
Fig. 20 depicts an example of a conventional ink cartridge structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] A specific embodiment of the present invention is now described with reference to the drawings.

[0038] Fig. 1 is a diagram of the ink cartridge according to this embodiment, showing it connected to a recording head. A head holder 50 for supporting the recording head 72 is mounted on a carriage 52 which moves so as to sweep across a recording medium. In this holder 50 is loaded the ink cartridge 1 so that it can be detached. An ink supply hole 17 made in the bottom surface of the ink cartridge 1 fits into a joint member 74 on the head holder 50 side, and ink is distributed through a manifold member 73 to many ink ejection channels in the recording head 72. The recording head 72 ejects ink from the ink ejection channels by the action of actuators consisting of piezoelectric elements or heating elements.

[0039] The ink cartridge 1 according to this embodiment comprises a case 2 made in a rectangular shape from a transparent or semi-transparent resin material, and upper and lower cover members 3 and 4. The case 2 consists of a pair of opposing first side walls 2a and 2b, and, connecting between that pair of side walls, a pair of second side walls 2c and 2d (cf. Fig. 2) so as to form a rectangular tube open at both the upper and lower ends. The upper and lower cover members 3 and 4

are heat welded so as to cover the open upper and lower tube ends. The case 2 is formed so that it is divided in the interior thereof by partitioning walls 5 and 6 that extend substantially parallel to the first side walls 2a and 2b (the left and right walls in Fig. 3), a bottom partitioning wall 7 that joins the lower ends of those two partitioning walls and extends substantially parallel to the open bottom tube end, and partitioning walls 7a, 7b, and 7c that extend vertically from the bottom partitioning wall 7 toward the bottom open tube end. The partitioning walls 5 and 6, the bottom partitioning wall 7, and the partitioning walls 7a and 7b extend so as to bridge between the second side walls 2c and 2d (cf. Fig. 2).

[0040] In the space enclosed by the partitioning walls 5 and 6, the bottom partitioning wall 7, and the second side walls 2c and 2d is formed a first chamber 9, the upper face whereof is open at the upper end of the case 2, which accommodates porous material 8 such as polyurethane foam absorbing ink. In the space enclosed by one of the first side walls 2a, the partitioning wall 5, and the second side walls 2c and 2d is formed a second chamber 10, while in the space enclosed by the other first side wall 2b, the partitioning wall 6, and the second side walls 2c and 2d is formed an atmosphere connection path 11. The second chamber 10 and the atmosphere connection path 11 are each open at their upper ends at the upper surface of the case 2, while the lower ends thereof bend around the lower surface of the bottom partitioning wall and have their lower ends open at the lower surface of the case 2 (cf. Fig. 4).

[0041] The upper cover member 3 covers the upper ends, respectively, of the first chamber 9, the second chamber 10, and the atmosphere connection path 11, and is secured by heat welding to the upper ends of the side walls 2a, 2b, 2c, and 2d and the partitioning walls 5 and 6, making the chambers 9 and 10 and the path 11 independent. The lower cover member 4 covers the lower ends, respectively, of the second chamber 10 and the atmosphere connection path 11, and is secured by heat welding to the lower ends of the side walls 2a, 2b, 2c, and 2d and the partitioning walls 7a and 7b, making the second chamber 10 and the path 11 independent. As a result, the second chamber 10 and the atmosphere connection path 11 substantially constitute an L shape with a vertical part 10a along the side walls 2a and 2b, and horizontal parts 10b and 11b positioned below the first chamber 9. The vertical part 11a and the horizontal part 11b of the atmosphere connection path 11 are connected through a connecting hole 30 provided in the partitioning wall 7b.

[0042] In the bottom partitioning wall 7 is formed a connecting hole 15 that connects the first chamber 9 and the second chamber 10. Ink is accommodated in both the first chamber 9 and the second chamber 10, and both of these chambers form the ink chamber. The second chamber 10 serves as a path during ink filling, as is described below, and serves as a relay chamber when ink is being supplied from the first chamber 9 to the recording head 72. The first chamber 9 is formed such that it is sufficiently larger than the second chamber 10. The atmosphere connection path 11 admits air to the first chamber 9 when ink in the first chamber 9 is consumed. A separation is made between the second chamber 10 and the atmosphere connection path 11 by the partitioning wall 7a at the lower surface of the bottom partitioning wall 7. As described in the foregoing, the partitioning walls 5 and 6 are made substantially parallel with the side walls 2a and 2b on either side of the case 2, rendering the sides in a more or less double-walled structure and strengthening the case. The case 2 shaped in this way can be easily formed of resin by a die that separates vertically up and down.

[0043] In the upper cover member 3 is formed an ink filling hole 13 corresponding with the open face at the upper end of the second chamber 10, and a pressure reduction hole 14 for reducing the pressure inside the case during ink filling, facing the open face at the upper end of the first chamber 9. The connecting hole 15 that mutually connects the second chamber 10 and the first chamber 9 is located at the end that is far from the side on which the ink filling hole 13 and pressure reduction hole 14 are located, that is, on the side opposite thereto, thereby enhancing ink filling efficiency and ink consumption efficiency, as will be described below.

[0044] The first chamber 9 and the atmosphere connection path 11 are connected by a path 16 formed so as to cross the upper end of the partitioning wall 6 in the upper cover member 3. More specifically, this path 16 has a concavity formed in the upper surface of the upper cover member 3, one end whereof communicates to the first chamber 9 via the pressure reduction hole 14, and the other end whereof communicates with the atmosphere connection path 11 via a through hole 16a. The upper cover member 3 has a wall 27 that is in contact with the upper surface of the porous material 8 projecting into the first chamber 9 (cf. Fig. 4). More specifically, the upper cover member 3 is formed so as to be thicker in the portion thereof corresponding with the first chamber 9, so as to slightly compress the ink absorbing material 8. The wall 27 is separated by an interval from the inner surface of the first chamber 9, as will be described below, and the pressure reduction hole 14 is positioned further to the inside of the first chamber 9 than the outer periphery of the wall 27.

[0045] In the lower cover member 4 is formed an ink supply hole 17 for supplying ink from the second chamber 10 to the recording head, corresponding to the open face at the lower end of the second chamber 10, and an atmosphere connection hole 17 corresponding to the open face at the lower end of the atmosphere connection path 11. As diagrammed in Fig. 6, the connecting hole 15 and the ink supply hole 17 are positioned so as to be mutually offset as seen from the bottom. In the second chamber 10, a rib-shaped baffle plate 31 is formed across the shortest path connecting the connecting hole 15 and the ink supply hole 17. This baffle

plate 31 is made to project integrally from the partitioning wall 7 of the case 2, and it is preferable that it be formed so as to join the inner wall surface of the lower cover member 4, but there is no reason why it cannot be made to project integrally from the lower cover member 4. The lower surface 7d of the bottom partitioning wall 7 (cf. Fig. 3) forms an inclined surface that rises from the lower end of the connecting hole 15 toward the vertical part of the second chamber 10. One end of the baffle plate 31 is positioned at the side of the connecting hole 15, while the other end thereof extends to a point near the vertical part of the second chamber 10. Thus, when ink is drawn from the second chamber 10 by the negative pressure developed by the ejection of ink from the recording head 72, the ink flow coming out of the connecting hole 15 from the first chamber 9 detours around the baffle plate 31, as indicated by the arrow 31, passes through the vertical part 10a of the second chamber 10, again enters the horizontal part 10b of the second chamber 10, and arrives at the ink supply hole 17.

[0046] As diagrammed in Fig. 4, the ink filling hole 13 and the pressure reduction hole 14, after ink filling, are closed off by first sealing materials 21 and 22 applied to the outer surface of the upper cover member 3 by heat welding or the like. Th sealing material 22 covers the upper surface thereof so as to secure the path 16. The ink supply hole 17 and the atmosphere connection hole 18 are closed off by a second sealing material 23 that is applied by heat welding or the like such that it can be peeled away. The ink filling hole 13 and the ink supply hole 17 are separated, wherefore the second sealing material 23 is applied to the ink supply hole 17 prior to ink filling. For this reason, the periphery of the ink supply hole 17 is not wet by ink during filling as with a conventional ink supply hole that doubles as the ink filling hole, wherefore an adequate sealing effect can be obtained even with mild heat welding such as will not deform the ink supply hole. The sealing materials 21 and 22 do not need to be peeled away, wherefore they may be heat welded more strongly even to the point of slightly deforming the upper cover member 3. The sealing materials 21, 22, and 23 are made of a resin, metal foil, or laminated material thereof that is not penetrable by air.

[0047] A stainless steel screen filter 24 is attached to the face of the ink supply hole 17 on the second chamber 10 side. The screen holes of this filter 24 are of a size such that the ink inside the second chamber 10 will not naturally leak out due to surface tension.

[0048] As diagrammed in Fig. 10, a partitioning wall 29 for partitioning the atmosphere connection path 11 into an upper and lower part is formed midway along the vertical part 11a of the atmosphere connection path 11. This partitioning wall 29 extends so that there are differences in height in the vertical direction of the atmosphere connection path 11. A through hole 28 is formed in the high portion thereof, and a concavity is formed so as to provide an ink sump 29a positioned lower than the upper end surface of the through hole 28. The partitioning wall 29 can be molded with the separating parts of a die that separates vertically up and down when molding the case 2 out of resin, thus requiring no special process.

[0049] By having the peripheral wall 18a of the atmosphere connection hole 18 in the lower cover member 4 project upward, moreover, an ink sump 4a is formed about the periphery thereof. By this means, ink that leaks out through the path 16 from the first chamber 9 when the ink cartridge falls over, etc., accumulates in the ink sump 29. The ink in the ink sump 29, even if it enters the through hole 28 by the ink cartridge being tilted, etc., will collect in the ink sump 4a below. Accordingly, the atmosphere connection path 11 and atmosphere connection hole 18 will not be plugged, nor will ink leak out to the outside.

[0050] As diagrammed in Fig. 6 and Fig. 19, in the case 2, a space 33 is formed adjacent to the horizontal parts 10b and 11b of the second chamber 10 and the atmosphere connection path 11. This space 33 is divided by the partitioning wall 7c that bridges between the partitioning walls 7a and 7b, is covered below by the lower cover member 4, and does not communicate with the second chamber 10, the first chamber 9, or the atmosphere connection path 11, but does communicate with the outside of the case through an opening 34 provided in the lower cover member 4. When an ink cartridge 1 that has been filled with ink is shipped, it is accommodated in a reduced pressure condition inside a packaging bag 81, as diagrammed in Fig. 19. The packaging bag 81 accommodates the ink cartridge 1 inside a tubular material, the interior whereof is evacuated with reduced pressure, and both open ends whereof are given fused closures 82. The packaging bag 81 is made of a resin, metal foil, or laminated material thereof that is not penetrable by air. The cross-section of the ink cartridge 1 diagrammed in Fig. 19 corresponds to a cross-section in the C-C plane in Fig. 9. The opening 34 is not covered by the second sealing material 23. When the packaging bag 81 is rendered in a reduced pressure condition, the space 33 is also rendered in a reduced pressure state, and acts, by the capacity thereof, to maintain the interior of the sealed packaging bag 81 in a reduced pressure condition for an extended period of time. Thus is the ink inside the case, prior to use, prevented from being exposed to air.

[0051] Fig. 11, 12, and 13 show details of the configuration of the path 16 parts. The configuration diagrammed in Fig. 11 is given as a reference for explaining problems. In this figure, the path 16b is formed so as to pass through the upper cover member 3a, thus mutually communicating between the first chamber 9 and the atmosphere connection path 11. The upper face of the path 16b is covered by the sealing material 22 (not shown). In this case, the intersection (ridge line) E1 formed by the partitioning wall 6 and the side walls 2c and 2d, and the intersection E2 formed by the partitioning wall 6 and the upper cover member 3, readily collect

ink through capillary action. Furthermore, because the intersections E1 and E2 are continuous with the intersection E3 formed by the inner surface of the path 16b and the partitioning wall 6, ink collected at the intersections E1 and E2 flow to the intersection E3 by capillary action, as indicated by the arrow R, and from there flow out along an intersection E4 inside the atmosphere connection path 11. When ink penetrates from the first chamber 9 toward the atmosphere connection path 11, an unsightly condition develops if the case is transparent or semi-transparent, and ink can also leak out to the exterior of the case or plug the atmosphere connection path 11. When this happens, the ink supply to the recording head 11 from the first chamber 9 is sometimes blocked.

[0052] In order to resolve the problem described above, an interval K is opened with the inner surface of the first chamber 9 about the periphery of the wall 27 that projects from the upper cover member 3 toward the first chamber 9, as diagrammed in Fig. 12. The pressure reduction hole 14 is given a circular cylindrical or rounded rectangular shape which does not have intersections on its inner surface, and positioned at the end of the wall 27, removed from the partitioning wall 6. With this configuration, the inside edge or intersection of the partitioning wall 6 on the first chamber 9 side does not connect with the path 16 or atmosphere connection path 11 only by an inside edge or intersection formed by two planes. In other words, the lower surface of the wall 27, the outer circumference of the wall 27, and the inner surface of the pressure reduction hole 14 are formed so that they do not have inside edge or intersections formed by two planes, and the intersection of the partitioning wall 6 on the first chamber 9 side connects with the atmosphere connection path 11 via these surface portions(flat portions). Accordingly, ink that oozes out when the porous material 8 is compressed by the wall 27 and ink collecting at the intersections on the first chamber 9 side are prevented from flowing out by capillary action to the path 16 or the atmosphere connection path 11. There are also no intersections on the inner surface of the pressure reduction hole 14 in contact with the porous material 8, and, in addition, since the pressure reduction hole 14 is positioned in the thick part of the upper cover member 3 and the height of the pressure reduction hole 14 is sufficient, the ink inside the porous material 8 is prevented from flowing along the inside of the pressure reduction hole 14 and penetrating to the path 16. Even supposing that the gap between the partitioning wall 6 and the outer periphery of the wall 27 is small and that ink rises through the gap due to capillary action, ink will not penetrate to the atmosphere connection path 11 because the upper end of the partitioning wall 6 is fused to the cover member 3.

[0053] When the pressure reduction hole 14 is shaped so that there is an intersection on the inner surface, the same effect can be realized by giving the inner surface of the path 16 an edgeless (no intersection) cross-section that has the shape of a semicircular cylinder or rounded rectangle.

[0054] In Fig. 13 is diagrammed an example of the path 16 portion diagrammed in Fig. 12 the structure of which has been modified. With the structure diagrammed in Fig. 13, the wall 27 has been eliminated, wherefore ink is prevented from rising along that wall to the path 16.

[0055] A remaining ink quantity detection sensor 60 is provided in the carriage 52 of the ink jet printer. More specifically, while the ink cartridge 1 is in the unused state, ink is filled into the porous material 8 in the first chamber 9 and in the second chamber 10 so that no space is left remaining. When the ink is consumed by a recording operation, however, and the ink in the first chamber 9 is depleted, due to the pressure wherewith the ink is drawn by the recording head 72, air enters the second chamber 10 from the first chamber 9, a gap portion develops at the top of the second chamber 10, and the ink liquid level falls. The remaining ink quantity detection sensor 60 detects whether or not there is a remaining ink quantity from changes in the light reflected according to whether or not ink is present on the inner wall surface of that second chamber 10.

[0056] The remaining ink quantity sensor 60 is configured, as shown in Fig. 15, with a light emitting element 61 and a light receiving element 62 provided on either side of a detection site α, with a prescribed interval opened in the horizontal direction of the second chamber 10, so that the light emitting element 61 emits light at the detection site α that is established at a prescribed height position on the side wall 2a of the case 2 looking toward the second chamber 10, and so that the light receiving element 62 can capture the light that is reflected from the inner surface of the side wall at that detection site α (cf. Fig. 5). For this purpose, the case 2 need only have that portion at the detection site α made transparent or semi-transparent in order to secure light transmissivity.

[0057] The detection site α is established, as diagrammed in Fig. 15, at the place (corner) where the ridge line is formed by the intersection of the inner surface of the side wall 2a and the side wall 2d adjacent thereto and extends up and down, inside the second chamber 10 of the ink cartridge 1. If the detection site α is established thusly at the ridge line (corner) of the second chamber 10, then, as will be described below, when the height of the ink fluid level inside the second chamber 10 falls precipitously from level h1 to level h2, as diagrammed in Fig. 14, even if the ink L adhering to the inner surface of the side wall 2a is held in the vicinity of level h1 in the center of the side wall 2a, the ink L that was adhering near the corner on the inner surface of the side wall 2a will move immediately to the vicinity of level h2 at the same height as the ink liquid level due to capillary action exhibited by the corner, wherefore the presence or absence of ink inside the second chamber 10 at the detection site α can be detected precisely. Such

a precipitous fall in the liquid level will occur when, after ink liquid level h2 has been shaken to h1 by the sweeping movement of the carriage, a suction cap (not shown) is connected to the recording head 72 and ink is drawn out.

[0058] It is also possible to provide a rib that protrudes from the inner surface of the side wall 2a into the second chamber 10 and extends in the height direction of the second chamber 10, and establish the detection site α at the ridge line formed by that rib and the inner surface of the side wall 2a. However, by establishing the detection site α in the corner that exists in an ordinary ink cartridge, as described in the foregoing, the detection precision of the remaining ink quantity sensor 60 can be enhanced without making the structure of the ink cartridge 1 complex.

[0059] Also, as discussed in the foregoing, by detecting the remaining ink quantity in the second chamber 10 where the ink liquid level fluctuation finally appears after almost all of the ink in the first chamber 9 has been consumed, the remaining ink quantity at the point in time where the ink cartridge 1 should be replaced can be made extremely small, so that ink waste that occurs when the ink cartridge 1 is replaced can be held to a minimum.

[0060] Furthermore, as diagrammed in Fig. 15, many finely undulating ribs 63 are formed on the inner surface of the side wall 2a looking into the second chamber 10 where the detection site α is established in a direction perpendicular to the plane containing the light emitting element 61, the light receiving element 62, and the detection site α, that is, in the vertical up and down direction of the ink cartridge 1, while on the outer surface of the side wall 2a where the detection site α is established, many finely undulating ribs 64 are formed in a direction parallel to the plane containing the light emitting element 61, the light emitting element 62, and the detection site α, that is, in the fore-and-aft direction of the ink cartridge 1.

[0061] In a state wherein ink is present up to the height of the detection site α in the second chamber 10, the light emitted from the light emitting element 61 advances into the ink (arrow B) due to the refractive indexes of the side wall 2a and the ink, but advances almost not at all toward the light emitting element 62. In a state wherein ink is not present at the detection site α, light is reflected by the inner surface of the side wall 2a and advances toward the light emitting element 62. At this time, if many fine undulating ribs 63 are formed on the inner surface of the side wall 2a of the case 2, extending vertically up and down, then, as indicated by the solid lines in Fig. 15, the light emitted from the light emitting element 61, when reflected by the inner surface of the side wall 2a of the case 2, is scattered in a substantially horizontal direction (i.e. in a direction parallel to the plane containing the light emitting element 61, the light emitting element 62, and the detection site α) by the undulating ribs 63, and advances toward the light emitting element 62 while spreading out in the plane containing the light emitting element 61 and the light emitting,element 62 of the sensor 60 and the detection site α on the case 2. The light reflected when no such undulating ribs are formed on the inner surface of the side wall 2a is indicated by the double-dotted lines in the same figure. Accordingly, as indicated by the solid lines and the double-dotted lines in Fig. 16, the light emitting element 62 can capture the reflected light in a definite way even when there are slight changes in the distance between the sensor 60 and the detection site α. In other words, even when variation in the sensor 60 attachment position relative to the carriage 52 arises during manufacture of the ink jet printer, or the ink cartridge 1 mounting position is shifted slightly when the user replaces the ink cartridge 1, the remaining ink quantity can be detected unambiguously. In the drawing, for convenience, the light is represented as being emitted from the light emitting element 61 in a parallel state, but the same benefit can be realized even if the light is emitted so that it spreads.

[0062] Furthermore, when many finely undulating ribs 64 are formed on the inner surface of the side wall 2a extending in a fore and aft direction, as described in the foregoing, the light that is reflected at the outer surface of the side wall 2a of the case 2 is scattered vertically upward and downward by the undulating ribs 64, and the light reflected at the outer surface of the side wall 2a proceeds toward the light emitting element 62 while spreading outside of the plane containing the light emitting element 61 and light emitting element 62 of the sensor 60 and the detection site α, wherefore it becomes difficult for the light emitting element 62 to capture that light that is reflected at the outer surface of the side wall 2a which does not contribute to the detection of the remaining ink quantity. That being so, of the reflected light that is captured by the light emitting element 62, the proportion of those components of the light reflected by the inner surface of the side wall 2a that do contribute to remaining ink quantity detection becomes high, whereupon remaining ink volume detection precision is enhanced. Hypothetically, in a case where the undulating ribs on the inner face of the side wall 2a extend in the horizontal direction, light would be scattered vertically up and down, wherefore, when the distance between the sensor 60 and the detection site α has changed, as diagrammed in Fig. 16, the allowable position whereat the light emitting element 62 can capture the reflected light would significantly more limited than in the embodiment described above.

[0063] The case 2 configured as described in the foregoing is formed in a die. In the die used for this purpose, the die face corresponding to the inner surface of the side wall 2a where the detection site α is established is polished in a direction perpendicular to the plane containing the light emitting element 61, the light emitting element 62, and the detection site α, and the die face corresponding to the outer surface of the side wall 2a where the detection site α is established is polished in

a direction parallel to the plane containing the light emitting element 61, the light emitting element 62, and the detection site α. By subjecting the die faces to polishing in this manner, the many finely undulating ribs extending in the prescribed directions are formed on the two die faces, respectively. Accordingly, by using such a die as this, an ink cartridge 1 can be easily manufactured wherein many undulating ribs 63 and 64 are formed in the prescribed directions on the inner surface and outer surface, respectively, of the side wall 2a where the detection site α is established.

[0064] With this embodiment, moreover, the light emitting element 61 and the light emitting element 62 are positioned in a horizontal orientation, but this does not constitute a limitation, and it is possible to position the light emitting element 61 and the light emitting element 62 in the vertical dimension of the ink cartridge 1. In that case, however, the orientations of the undulating ribs 63 and 64 formed in the inside and outside surfaces of the side wall 2a, respectively, must be reversed.

[0065] The method of fabricating the ink cartridge 1 is described next. The case 2 is first molded out of resin, then washed and dried. At this time, both the upper and lower faces of the case 2 are open, wherefore the case 2 can be easily molded with a die that separates up and down. The case must be washed well so that the ink properties do not change, but, with this case shape, the washing liquid readily reaches into the interior portions, so washing can be done easily. Drying can also be performed so that no washing liquid remains.

[0066] As diagrammed in Fig. 4, the porous material 8 is inserted into the first chamber 9 from the upper open end of the case 2. This porous material 8 is accommodated in a compressed condition because the upper cover member 3 pushes against it. The upper cover member 3 is heat welded around the lip of the upper opening in the case 2 and at the upper ends of the partitioning walls 5 and 6. The lower cover member 4 is secured by heat welding around the lip of the lower opening in the case 2 and at the lower ends of the partitioning walls 7a, 7b, and 7c. To the ink supply hole 17 and atmosphere connection hole 18 in the lower cover member 4 is applied a sealing material 23, which can be peeled away, for covering them. Thus the top and bottom of the case 2 are formed in a substantially open condition. By mounting the cover members 3 and 4 from the top and bottom, the various types of chamber described earlier can be formed, making the assembly thereof easy. The ink supply hole 17 and the atmosphere connection hole 18 are lined up on one side of the cartridge, wherefore the sealing material 23 for covering these can be applied easily, without the need of being pulled around the outer periphery of the cartridge as conventionally.

[0067] The operation of filling the inside of the ink cartridge 1 with ink is next described. As diagrammed in Fig. 18, with the ink supply hole 17 and the atmosphere connection hole 18 in the lower cover member 4 sealed as described above, an ink filling apparatus 101 is tightly fitted to the ink filling hole 13 and a pressure reduction apparatus 102 is tightly fitted to the pressure reduction hole 14 in the upper cover member 3, as diagrammed in Fig. 18, and the apparatuses are activated. Because the ink filling hole 13 and the pressure reduction hole 14 are lined up on one side of the cartridge, the apparatuses need only be brought up against one side of the cartridge 1. The air inside the first chamber 9 is sucked out from the pressure reduction hole 14 prior to ink filling. The pressure in the first and second chambers 9 and 10 is thereby reduced, whereupon the ink passes from the ink filling hole 13 through the second chamber 10 and the connecting hole 15 and thus fills the porous material 8 inside the first chamber 9. When this is done, the second chamber 10 becomes an ink filling path. The ink enters the second chamber 10 from one end, passes through the connecting hole 15 that is maximally separated therefrom, and enters the first chamber 9, after which it reaches the pressure reduction hole 14 that is maximally separated from the connecting hole 15, wherefore the second chamber 10 itself can be completely filled with ink, while, at the same time, the first chamber 9 can also be efficiently filled with ink. Also, as described in the foregoing, the outside of the case 2 is a reinforced double-walled structure, wherefore the case 2 will not be deformed very much during pressure reduction, for which reason also the two chambers 9 and 10 can be efficiently filled with ink. The pressure in the atmosphere connection path 11 is also reduced simultaneously with the first chamber 9, and the reduced pressure state is maintained even after the sealing material is applied.

[0068] For the ink loaded by this process, ink (so-called deaerated ink) is used from which bubbles and air dissolved therein has been removed to the extent possible. The purpose of this is to avoid ink ejection problems that arise when bubbles and air penetrate into the recording head 72. And the ink cartridge is hermetically sealed under reduced pressure in the packaging bag 8, as described earlier, in order to prevent bubbles and air from again being dissolved in the deaerated ink.

[0069] After ink filling, sealing materials 21 and 22 are applied to the ink filling hole 13 and the pressure reduction hole 14. The sealing materials 21 and 22 may be applied in a single strip if, afterwards, only the necessary portions are left remaining. Thus, in the manufacturing stage, the filling apparatus 101 and the pressure reduction apparatus 102 need only be brought up against the case 2 from one side, and the seals need be only applied from one side of the case 2 also, making for efficient operations.

[0070] The ink cartridge 1 fabricated in this manner is shipped after being hermetically sealed under reduced pressure inside the packaging bag 81, as described earlier.

[0071] When the ink cartridge 1 is used by the user, the user peels away the sealing material 23 applied to

the ink supply hole 17 and the atmosphere connection hole 18 of the ink cartridge 1, and couples the ink supply hole 17 via the joint member 74 to the manifold 73 in the recording head 72. Then a suction cap is connected to the recording head 72 and the recording head 72 is filled with ink from the ink cartridge 1, as is commonly known.

[0072] During a recording operation, due to the suction force of the porous material 8 inside the first chamber 9, that is, due to capillary action, a negative pressure is caused to act on the ink supplied to the recording head from the second chamber 10. The actuators in the recording head 72 perform an ink ejecting action, thereby producing a negative pressure in the ejection direction and drawing out ink from the ink cartridge 1. When the ink in the second chamber 10 flows out from the ink supply hole 17, ink is replenished in the second chamber 10 from the porous material 8 in the first chamber 9, and air is inducted from the atmosphere connection hole 18 through the atmosphere connection path 11 into the first chamber 9 as the ink in the first chamber 9 is consumed. The upper end of the second chamber 10 is sealed by the sealing material 21. Therefore, because the second chamber 10 completely filled with ink, atmospheric pressure does not act on the ink in the second chamber 10, wherefore the ink in the second chamber 10 will be consumed after the ink in the first chamber 9 is almost completely depleted. In other words, when the ink in the first chamber 9 is gone, due to the pressure of the recording head 72 drawing the ink, the ink in the second chamber 10 is consumed while air from the first chamber 9 enters the second chamber 10, whereupon a gap develops at the top of the vertical part of the second chamber 10 and the ink liquid level therein begins to fall.

[0073] Thus, in the first chamber 9, atmospheric air is drawn in from the side distant from the connecting hole 15, so that not only is the ink in the first chamber 9 utilized effectively, but all of the ink, including the ink that is in the second chamber 10, is used effectively. Also, because the second chamber 10 is completely filled from the beginning as an ink filling path, during remaining ink quantity detection, detection errors will not be made due to inadequate ink filling here. The operation of removing the sealing material 23 is also easy because it is done only on one side of the cartridge.

[0074] As described in the foregoing, furthermore, there is a gap 31 between the connecting hole 15 and the ink supply hole 17, wherefore, when ink is drawn from the first chamber 9 through the connecting hole 15 into the second chamber 10 by the pressure caused by the recording head 72 sucking ink, when air bubbles are mixed into that ink, or the ink in the first chamber 9 is consumed so that air is drawn into the second chamber 10 as described earlier, those bubbles and air can be blocked from flowing into the recording head 72. In other words, when the ink flow detours around the baffle plate 31, as indicated by the arrow 32 in Fig. 6, in the vicinity corresponding to the vertical part 10a of the second chamber 10, the air and bubbles travel toward the top of the vertical part 10a due to buoyancy, and hence do not reach the ink supply hole 17. The ceiling surface of the horizontal part 10b of the second chamber 10, that is, the lower surface 7d of the bottom partitioning wall 7, is inclined so that it rises from the lower end of the connecting hole 15 toward the vertical part 10a of the second chamber 10, wherefore air and bubbles do not become trapped at the lower surface of the bottom partitioning wall 7 but rather flow toward the top of the vertical part 10a. That being so, bubbles and air can be prevented from penetrating to the recording head 72 and causing ink ejection failures.

Claims

1. An ink cartridge for attachment to a recording head for holding ink to be supplied to the recording head, comprising:

   a case (2) having a first surface and a second surface in opposition, the first and second surfaces are open;
   a first partitioning wall (6) for separating the interior of the case into an ink chamber (9) for holding ink and an atmosphere connection path (11) communicating to the outside of the case (2), wherein the ink chamber (9) is open on the first surface and the second surface sides;
   a first cover (3) for covering the first surface of the case (2) so that a path (16) is formed for communicating between the ink chamber (9) and the atmosphere connection path (11);
   a second cover (4) for covering the second surface of the case (2); and
   an ink supply hole (17) for joining to the recording head, formed in the second cover (4) so as to communicate with the ink chamber (9).

2. The ink cartridge according to claim 1, further comprising a second partitioning wall (5) for dividing the ink chamber into a first chamber (9) for accommodating a porous material (8) absorbing ink and a second chamber (10) holding ink, wherein one of the first chamber (9) and the second chamber (10) is covered by the first cover (3) and the other of the chambers is covered by the second cover (4).

3. The ink cartridge according to claim 2, wherein the first chamber (9) communicates with the atmosphere connection path (11) near the first surface (3), and communicates with the second chamber (10) near the second surface, and the second chamber (10) communicates with the ink supply hole (17).

4. An ink cartridge according to claim 1 wherein:

   the case (2) has a first side wall (2b) and second

side wall (2a) opposed to the first side wall;
the first partitioning wall (6) is positioned substantially parallel to the first side wall (2b) of the case (2);
the cartridge further comprises a second partitioning wall (5) positioned substantially parallel to the second side wall (2a) of the case (2) so as to separate the ink chamber into a first chamber (9) and a second chamber (10) for respectively accommodating ink;
one end of the second chamber (10) communicates (15) with one end of the first chamber (9);
the other end of the second chamber (10) is open (13) to the outside of the case (2);
one end of the atmosphere connection path (11) communicates (14) with the other end of the first chamber (9); and
the other end of the atmosphere connection path (11) is open (18) to the outside of the case (2).

5. The ink cartridge according to claim 4, wherein the atmosphere connection path (11) is defined between the first side wall (2b) and the first partitioning wall (6), and the second chamber (10) is defined between the second side wall (2a) and the second partitioning wall (5).

6. The ink cartridge according to claim 4 or 5, wherein the ink in the first chamber (9) passes through the second chamber (10) and is supplied to the recording head from the ink supply hole (17).

7. The ink cartridge according to claim 6, wherein the other end of the first chamber (9) is open, the open part is covered by a first cover (3), the one end of the second chamber (10) is open, the open part is covered by a second cover (4), and the ink supply hole (17) is formed in the second cover (4).

8. The ink cartridge according to claim 5, 6 or 7 further comprising, inside the case (2), a third partitioning wall (7) that is joined to the lower ends of the first partitioning wall (6) and the second partitioning wall (5) while extending in a direction substantially perpendicular to the first side wall (2a), wherein the first chamber (9) is divided by the first (6) and third (7) partitioning walls, and a connecting hole (15) for connecting the first (9) and second (10) chambers is formed in the third partitioning wall (7).

9. The ink cartridge according to claim 8, wherein the other end of the first chamber (9) is open, the open part is covered by the first cover (3), an ink filling hole (13) for connecting the second chamber (10) and the outside of the case (2) is formed in the first cover (3), the one end of the second chamber (10) is open, the open part is covered by the second cover (4), and an atmosphere connection hole (18) for communicating with the atmosphere connection path (11) is formed in the second cover (4).

10. An ink cartridge according to claim 1 for holding ink to be supplied to a recording head, comprising:

a second partitioning wall (5) for dividing the ink chamber into first (9) and second (10) chambers for accommodating ink, respectively, wherein the first (9) and second (10) chambers mutually communicate (15) near the lower case surface (4);
an ink filling hole (13) for filling the second chamber (10) with ink, formed in the first surface (3);
a sealing material (21) for closing off the ink filling hole (13); and
an atmosphere connection hole (14) for connecting the first chamber (9) to an atmosphere outside of the case,

wherein:

the ink supply hole (17) is for supplying ink to the recording head from the second chamber (10), formed in the second surface (4);
the second chamber (10) is formed between one side wall (2a) of the case (2) and the second partitioning wall (5); and
at least one portion of the one side wall (2a) is transparent or semi-transparent.

11. The ink cartridge according to claim 10, wherein the first chamber (9) has a larger capacity than the second chamber (10) and accommodates a porous material (8) absorbing ink.

12. The ink cartridge according to claim 11, wherein the ink filling hole (13) is formed in the first cover (3).

13. The ink cartridge according to claim 10, 11 or 12 wherein an inner surface of the transparent or semi-transparent part of the one side wall (2a) has undulating ribs extending vertically up and down.

Patentansprüche

1. Eine Tintenpatrone zur Befestigung an einem Aufzeichnungskopf zum Bereithalten von dem Aufzeichnungskopf zuzuführender Tinte, die aufweist:

ein Gehäuse (2), das eine erste Oberfläche und eine zweite Oberfläche gegenüberliegend aufweist, wobei die erste und die zweite Oberfläche offen sind;
eine erste Trennwand (6) zum Aufteilen des In-

neren des Gehäuses in eine Tintenkammer (9) zum Bereithalten von Tinte und einen Atmosphärenverbindungspfad (11), der mit der Außenseite des Gehäuses (2) kommuniziert, wobei die Tintenkammer (9) auf den Seiten der ersten Oberfläche und der zweiten Oberfläche offen ist;
eine erste Abdeckung (3) zum Bedecken der ersten Oberfläche des Gehäuses (2), sodass ein Pfad (16) zum Kommunizieren zwischen der Tintenkammer (9) und dem Atmosphärenverbindungspfad (11) gebildet ist;
eine zweite Abdeckung (4) zum Bedecken der zweiten Oberfläche des Gehäuses (2); und
ein Tintenzuführloch (17) zum Verbinden mit dem Aufzeichnungskopf, das derart in der zweiten Abdeckung (4) ausgebildet ist, dass es mit der Tintenkammer (9) kommuniziert.

2. Die Tintenpatrone nach Anspruch 1, die ferner aufweist:

eine zweite Trennwand (5) zum Unterteilen der Tintenkammer in eine erste Kammer (9) zum Aufnehmen eines Tinte absorbierenden porösen Materials (8) und eine zweite Kammer (10), die Tinte bereithält, wobei eine von der ersten Kammer (9) und der zweiten Kammer (10) durch die erste Abdeckung (3) bedeckt ist und die andere der Kammern durch die zweite Abdeckung (4) bedeckt ist.

3. Die Tintenpatrone nach Anspruch 2, bei der die erste Kammer (9) nahe der ersten Oberfläche (3) mit dem Atmosphärenverbindungspfad (11) kommuniziert und nahe der zweiten Oberfläche mit der zweiten Kammer (10) kommuniziert und die zweite Kammer (10) mit dem Tintenzuführloch (17) kommuniziert.

4. Eine Tintenpatrone nach Anspruch 1, bei der
das Gehäuse (2) eine erste Seitenwand (2b) und eine der ersten Seitenwand gegenüberliegende zweite Seitenwand (2a) aufweist;
die erste Trennwand (6) im Wesentlichen parallel zu der ersten Seitenwand (2b) des Gehäuses (2) angeordnet ist;
die Patrone ferner eine zweite Trennwand (5) aufweist, die im Wesentlichen parallel zu der zweiten Seitenwand (2a) des Gehäuses (2) angeordnet ist, damit die Tintenkammer in eine erste Kammer (9) und eine zweite Kammer (10) zum jeweiligen Aufnehmen von Tinte aufgeteilt ist;
ein Ende der zweiten Kammer (10) mit einem Ende der ersten Kammer (9) kommuniziert (15);
das andere Ende der zweiten Kammer (10) zu der Außenseite des Gehäuses (2) offen ist (13);
ein Ende des Atmosphärenverbindungspfads (11) mit dem anderen Ende der ersten Kammer (9) kommuniziert (14); und
das andere Ende des Atmosphärenverbindungspfads (11) zu der Außenseite des Gehäuses (2) offen ist (18).

5. Die Tintenpatrone nach Anspruch 4, bei der der Atmosphärenverbindungspfad (11) zwischen der ersten Seitenwand (2b) und der ersten Trennwand (6) bestimmt ist und die zweite Kammer (10) zwischen der zweiten Seitenwand (2a) und der zweiten Trennwand (5) bestimmt ist.

6. Die Tintenpatrone nach Anspruch 4 oder 5, bei der die Tinte in der ersten Kammer (9) durch die zweite Kammer (10) hindurchtritt und von dem Tintenzuführloch (17) dem Aufzeichnungskopf zugeführt wird.

7. Die Tintenpatrone nach Anspruch 6, bei der das andere Ende der ersten Kammer (9) offen ist, der offene Teil durch eine erste Abdeckung (3) bedeckt ist, das eine Ende der zweiten Kammer (10) offen ist, der offene Teil durch eine zweite Abdeckung (4) bedeckt ist und das Tintenzuführloch (17) in der zweiten Abdeckung (4) ausgebildet ist.

8. Die Tintenpatrone nach Anspruch 5, 6 oder 7, die weiter aufweist: eine dritte Trennwand (7) im Inneren des Gehäuses (2), die zu den unteren Enden der ersten Trennwand (6) und der zweiten Trennwand (5) verbunden ist während sie sich in einer Richtung im Wesentlichen senkrecht zu der ersten Seitenwand (2a) erstreckt, wobei die erste Kammer (9) durch die erste (6) und die dritte (7) Trennwand geteilt ist und ein Verbindungsloch (15) zum Verbinden der ersten (9) und der zweiten (10) Kammer in der dritten Trennwand (7) ausgebildet ist.

9. Die Tintenpatrone nach Anspruch 8, bei der das andere Ende der ersten Kammer (9) offen ist, der offene Teil durch die erste Abdeckung (3) bedeckt ist, ein Tintenfüllloch (13) zum Verbinden der zweiten Kammer (10) und der Außenseite des Gehäuses (2) in der ersten Abdeckung (3) gebildet ist, das eine Ende der zweiten Kammer (10) offen ist, der offene Teil durch die zweite Abdeckung (4) bedeckt ist und ein Atmosphärenverbindungsloch (18) zum Kommunizieren mit dem Atmosphärenverbindungspfad (11) in der zweiten Abdeckung (4) ausgebildet ist.

10. Eine Tintenpatrone nach Anspruch 1 zum Bereithalten von einem Aufzeichnungskopf zuzuführender Tinte, die aufweist:

eine zweite Trennwand (5) zum Teilen der Tintenkammer in eine erste (9) und eine zweite (10) Kammer zum jeweiligen Aufnehmen von

Tinte, wobei die erste (9) und die zweite (10) Kammer nahe der unteren Gehäuseoberfläche (4) gegenseitig kommunizieren (15);
ein Tintenfüllloch (13) zum Füllen der zweiten Kammer (10) mit Tinte, das in der ersten Oberfläche (3) ausgebildet ist;
ein Verschlussmaterial (21) zum Absperren des Tintenfüllloches (13); und
ein Atmosphärenverbindungsloch (14) zum Verbinden der ersten Kammer (9) mit einer Atmosphäre außerhalb des Gehäuses,

wobei

das Tintenfüllloch (17) zum Zuführen von Tinte von der zweiten Kammer (10) zu dem Aufzeichnungskopf in der zweiten Oberfläche (4) ausgebildet ist;

die zweite Kammer (10) zwischen einer Seitenwand (2a) des Gehäuses (2) und der zweiten Trennwand (5) ausgebildet ist; und

zumindest ein Abschnitt der einen Seitenwand (2a) transparent oder semi-transparent ist.

11. Die Tintenpatrone nach Anspruch 10, bei der die erste Kammer (9) ein größeres Fassungsvermögen als die zweite Kammer (10) aufweist und ein Tinte absorbierendes poröses Material (8) beherbergt.

12. Die Tintenpatrone nach Anspruch 11, bei der das Tintenfüllloch (13) in der ersten Abdeckung (3) ausgebildet ist.

13. Die Tintenpatrone nach Anspruch 10, 11 oder 12, bei der eine innere Oberfläche des transparenten oder semi-transparenten Teils der einen Seitenwand (2a) wellenförmig verlaufende Rippen aufweist, die sich vertikal auf und ab erstrecken.

Revendications

1. Cartouche d'encre à attacher sur une tête d'enregistrement pour maintenir de l'encre devant être alimentée vers une tête d'enregistrement, comprenant :

une boîte (2) ayant une première surface et une seconde surface en opposition, la première et seconde surfaces sont ouvertes ;
une première paroi (6) de cloisonnement pour séparer l'intérieur de la boîte en une chambre (9) d'encrage pour maintenir de l'encre et un passage (11) de connexion atmosphérique communiquant vers l'extérieur de la boîte (2), dans laquelle la chambre (9) d'encrage est ouverte sur les côtés de la première surface et de la seconde surface ;
un premier couvercle (3) pour couvrir la première surface de la boîte (2) de sorte qu'un passage (16) est formé pour communiquer entre la chambre (9) d'encrage et le passage (11) de connexion atmosphérique ;
un second couvercle (4) pour couvrir la seconde surface de la boîte (2) ; et
un trou (17) d'alimentation en encre pour joindre à la tête d'enregistrement, formé dans le second couvercle (4) afin de communiquer avec la chambre (9) d'encrage.

2. Cartouche d'encre selon la revendication 1, comprenant en outre une seconde paroi (5) de cloisonnement pour diviser la chambre d'encre en une première chambre (9) pour loger un matériau poreux (8) absorbant de l'encre et une seconde chambre (10) maintenant de l'encre, dans laquelle l'une parmi la première chambre (9) et la seconde (10) est couverte par le premier couvercle (3) et l'autre parmi les chambres est couverte par le second couvercle (4).

3. Cartouche d'encre selon la revendication 2, où la première chambre (9) communique avec le passage (11) de connexion atmosphérique près de la première surface (3), et communique avec la seconde chambre (10) près de la seconde surface, et la seconde chambre (10) communique avec le trou (17) d'alimentation en encre.

4. Cartouche d'encre selon la revendication 1, dans laquelle :

la boîte (2) a une première paroi (2b) latérale et une seconde paroi (2a) latérale opposée à la première paroi latérale ;
la première paroi (6) de cloisonnement est positionnée sensiblement en parallèle à la première paroi (2b) latérale de la boîte (2) ;
la cartouche comprend en outre une seconde paroi (5) de cloisonnement positionnée sensiblement en parallèle à la seconde paroi (2a) latérale de la boîte (2) afin de séparer la chambre d'encre en une première chambre (9) et une seconde chambre (10) pour respectivement loger de l'encre ;
une extrémité de la seconde chambre (10) communique (15) avec une extrémité de la première chambre (9) ;
l'autre extrémité de la seconde chambré (10) est ouverte (13) vers l'extérieur de la boîte (2) ;
une extrémité du passage (11) de connexion atmosphérique communique (14) avec l'autre extrémité de la première chambre (9) ; et
l'autre extrémité du passage (11) de connexion atmosphérique est ouverte (18) vers l'extérieur de la boîte (2).

5. Cartouche d'encre selon la revendication 4, dans laquelle le passage (11) de connexion atmosphérique est défini entre la première paroi (2b) latérale et la première paroi (6) de cloisonnement, et la seconde chambre (10) est définie entre la seconde paroi (2a) latérale et la seconde paroi (5) de cloisonnement.

6. Cartouche d'encre selon la revendication 4 ou 5, dans laquelle l'encre dans la première chambre (9) passe au travers de la seconde chambre (10) et est alimentée vers la tête d'enregistrement depuis le trou (17) d'alimentation en encre.

7. Cartouche d'encre selon la revendication 6, dans laquelle l'autre extrémité de la première chambre (9) est ouverte, la partie ouverte est couverte par un premier couvercle (3), l'extrémité de la seconde chambre (10) est ouverte, la partie ouverte est couverte par un second couvercle (4), et le trou (17) d'alimentation en encre est formé dans le second couvercle (4).

8. Cartouche d'encre selon la revendication 5, 6 ou 7 comprenant en outre, à l'intérieur de la boîte (2), une troisième paroi (7) de cloisonnement qui est jointe sur les extrémités inférieures de la première paroi (6) de cloisonnement et la seconde paroi (5) de cloisonnement tandis qu'elle s'étend dans une direction sensiblement perpendiculaire à la première paroi (2a) latérale, dans laquelle la première chambre (9) est divisée par les première (6) et troisième (7) parois de cloisonnement, et un trou (15) de connexion pour connecter les première (9) et seconde (10) chambres est formé dans la troisième paroi (7) de cloisonnement.

9. Cartouche d'encre selon la revendication 8, dans laquelle l'autre extrémité de la première chambre (9) est ouverte, la partie ouverte est couverte par le premier couvercle (3), un trou (13) de remplissage d'encre pour connecter la seconde chambre (10) et l'extérieur de la boîte (2) est formé dans le premier couvercle (3), l'extrémité de la seconde chambre (10) est ouverte, la partie ouverte est couverte par le second couvercle (4), et un trou (18) de connexion atmosphérique pour communiquer avec le passage (11) de connexion atmosphérique est formé dans le second couvercle (4).

10. Cartouche d'encre selon la revendication 1 pour maintenir de l'encre devant être alimentée vers une tête d'enregistrement, comprenant :

une seconde paroi (5) de cloisonnement pour diviser la chambre d'encre en une première (9) et une seconde (10) chambres pour loger de l'encre, respectivement, dans laquelle les première (9) et seconde (10) chambres communiquent (15) mutuellement près de la surface (4) de boîte inférieure ;
un trou (13) de remplissage d'encre pour remplir la seconde chambre (10) avec de l'encre, formé dans la première surface (3) ;
un matériau (21) d'étanchéité pour fermer le trou (13) de remplissage d'encre ; et
un trou (14) de connexion atmosphérique pour connecter la première chambre (9) à une atmosphère à l'extérieur de la boîte, dans lequel :

le trou (17) d'alimentation en encre est pour alimenter en encre la tête d'enregistrement depuis la seconde chambre (10), formé dans la seconde surface (4) ;
la seconde chambre (10) est formée entre une paroi (2a) latérale de la boîte (2) et la seconde paroi (5) de cloisonnement ; et
au moins une partie de la paroi (2a) latérale est transparente ou semi-transparente.

11. Cartouche d'encre selon la revendication 10, dans laquelle la première chambre (9) a une capacité plus grande que la seconde chambre (10) et loge un matériau poreux (8) absorbant l'encre.

12. Cartouche d'encre selon la revendication 11, dans laquelle le trou (13) de remplissage d'encre est formé dans le premier couvercle (3).

13. Cartouche d'encre selon la revendication 10, 11 ou 12 dans laquelle une surface interne de la partie transparente ou semi-transparente de la paroi (2a) latérale a des nervures ondulées s'étendant verticalement vers le haut et vers le bas.

Fig. 1

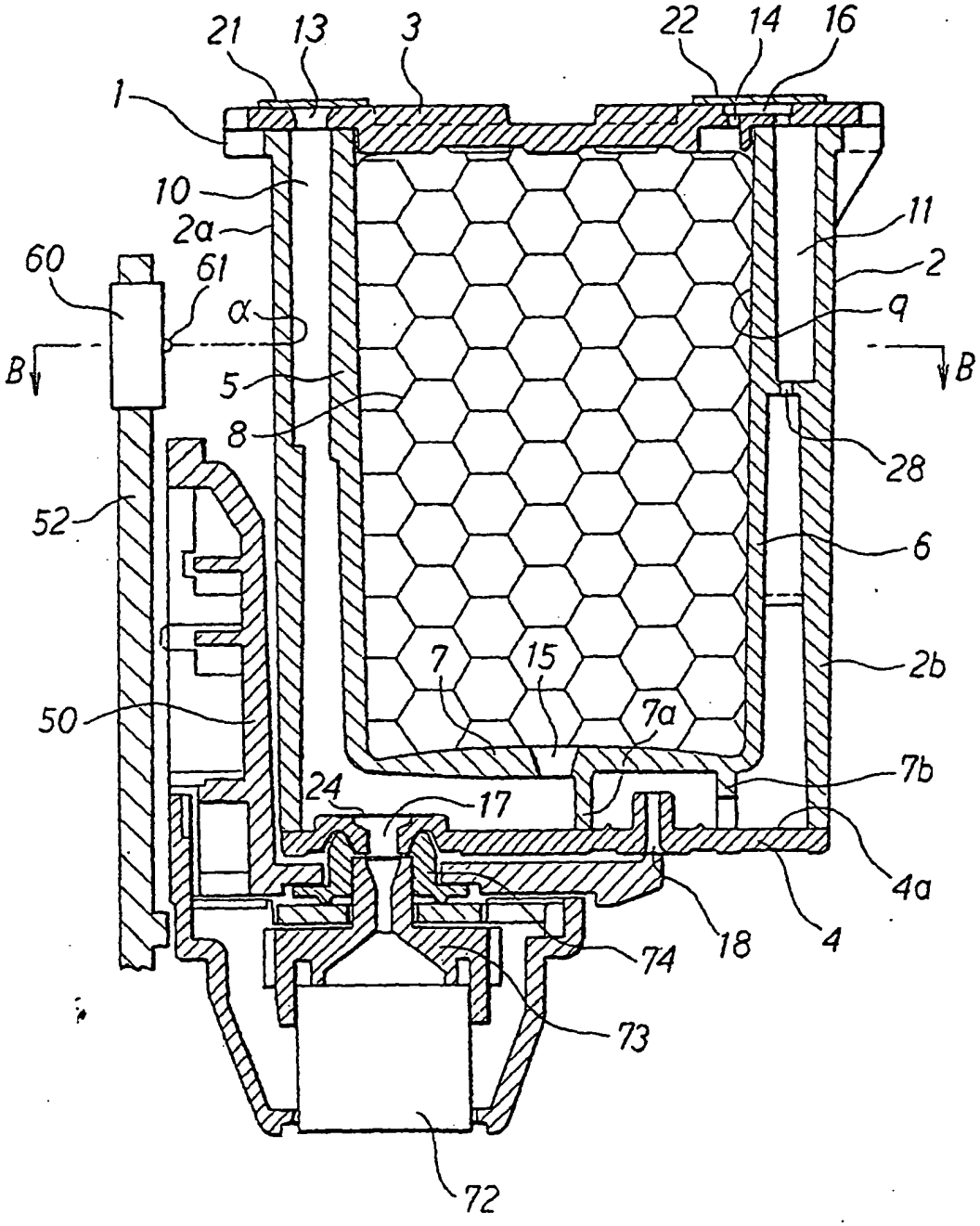

21
13
3
22
14
16
1
10
2a
11
60
61
2
α
9
B
B
5
8
28
52
6
7
15
2b
50
7a
7b
24
17
4a
18
4
74
73
72

Fig. 2

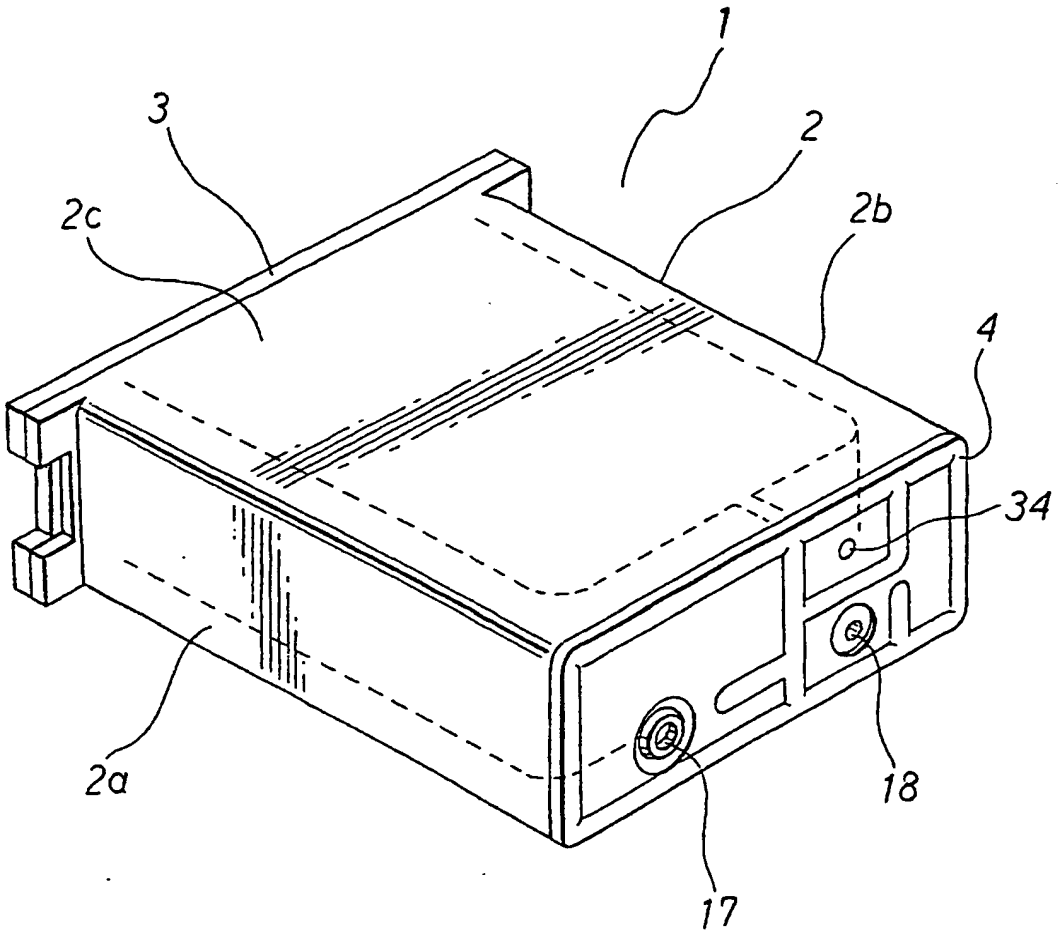


Fig. 3

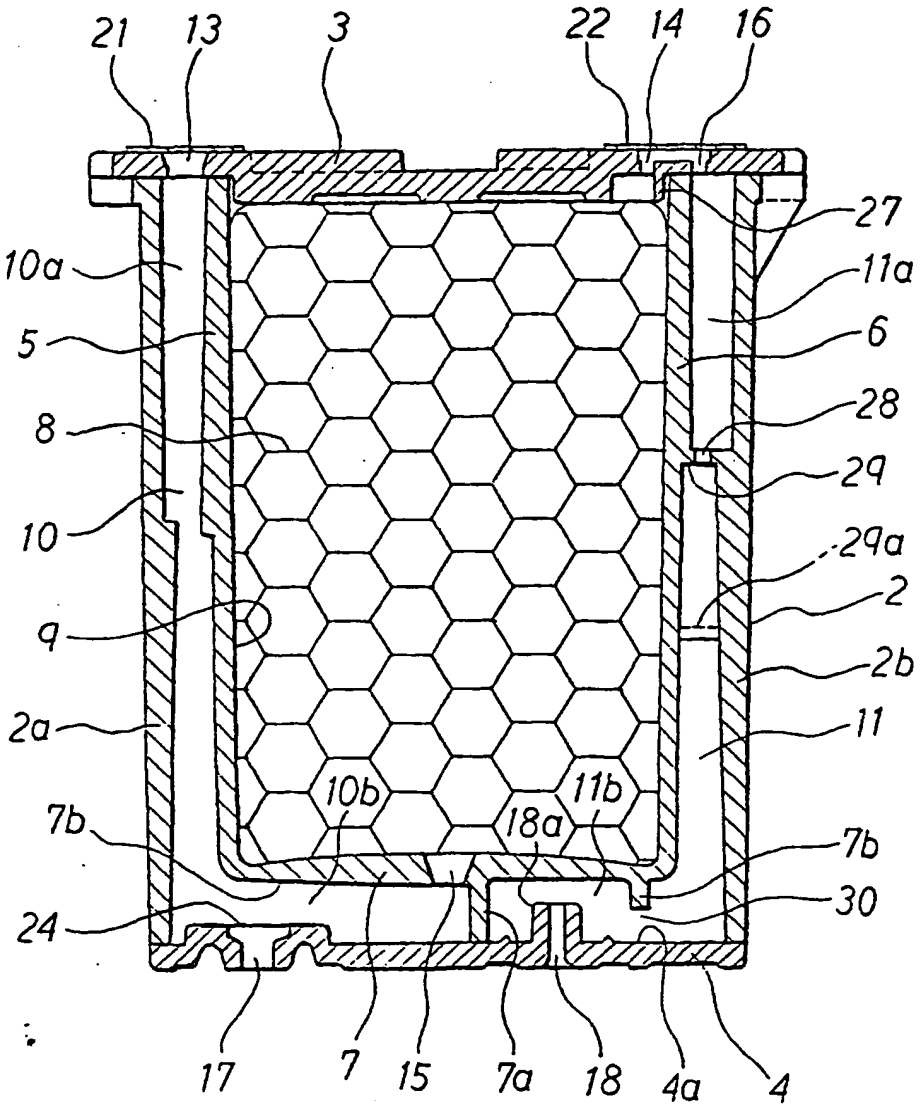

21
13
3
22
14
16
27
10a
11a
5
6
8
28
29
10
29a
2
9
2b
2a
11
10b
11b
18a
7b
7b
24
30
17
7
15
7a
18
4a
4

Fig. 4

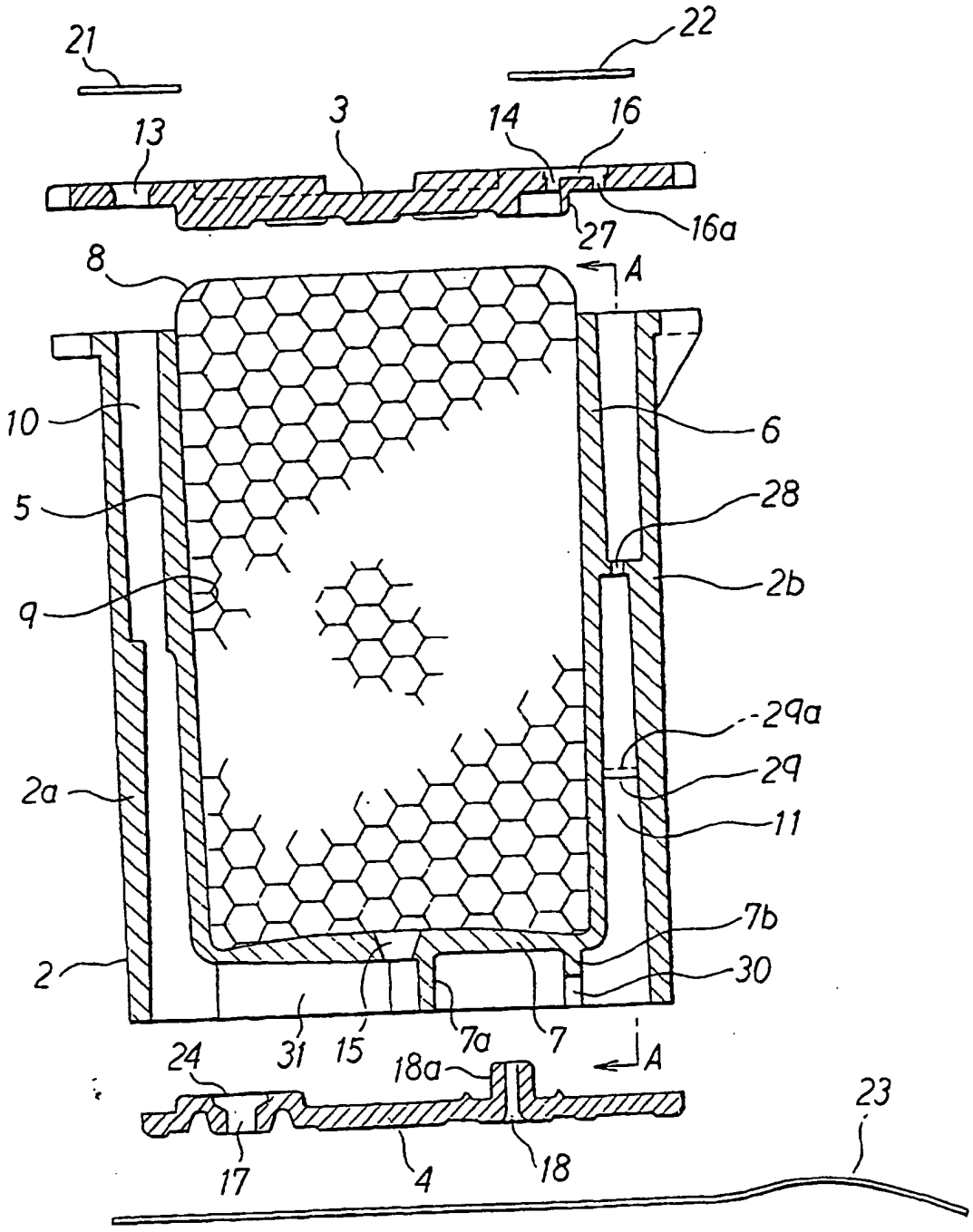

21
22
13
3
14
16
27
16a
8
A
10
6
5
28
9
2b
29a
29
2a
11
7b
2
30
31
15
7a
7
A
24
18a
23
17
4
18

Fig. 5

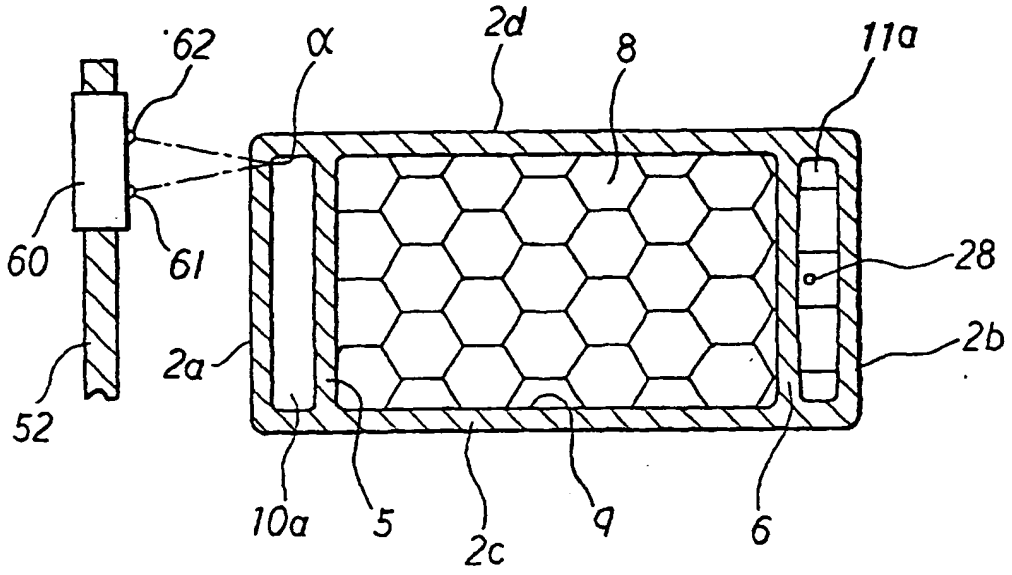

62
α
2d
8
11a
60
61
28
2b
2a
52
10a
5
2c
9
6

Fig. 6

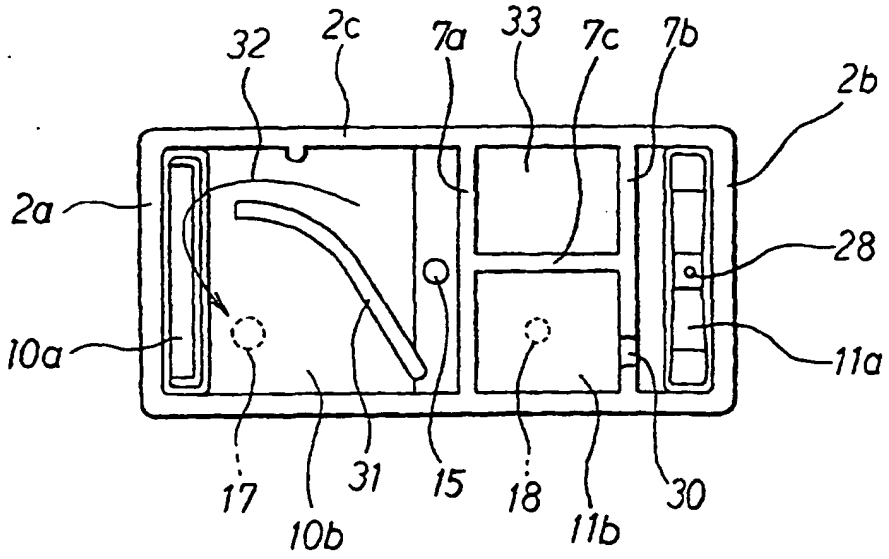

32
2c
7a
33
7c
7b
2b
2a
28
10a
11a
17
10b
31
15
18
11b
30

Fig. 7

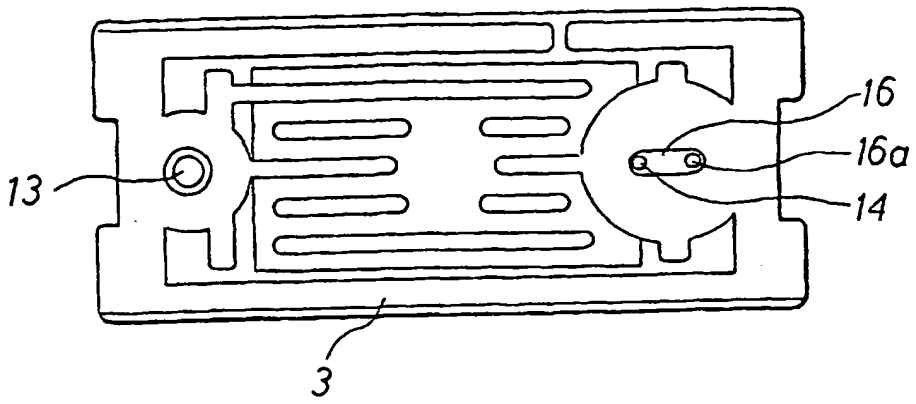


Fig. 8

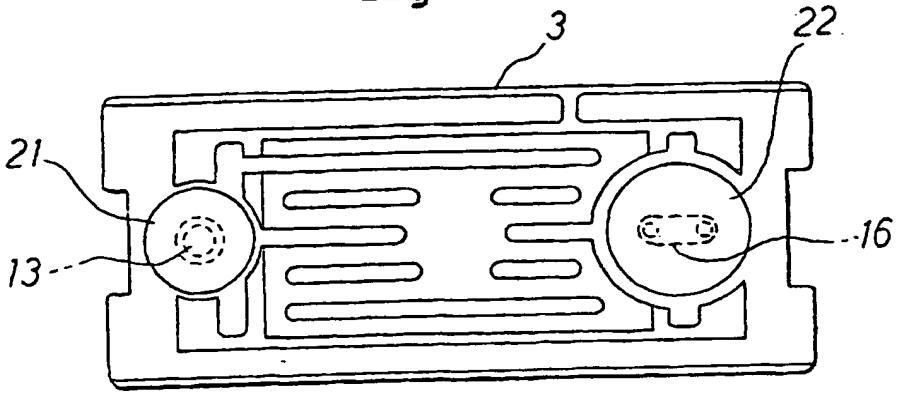


Fig. 9

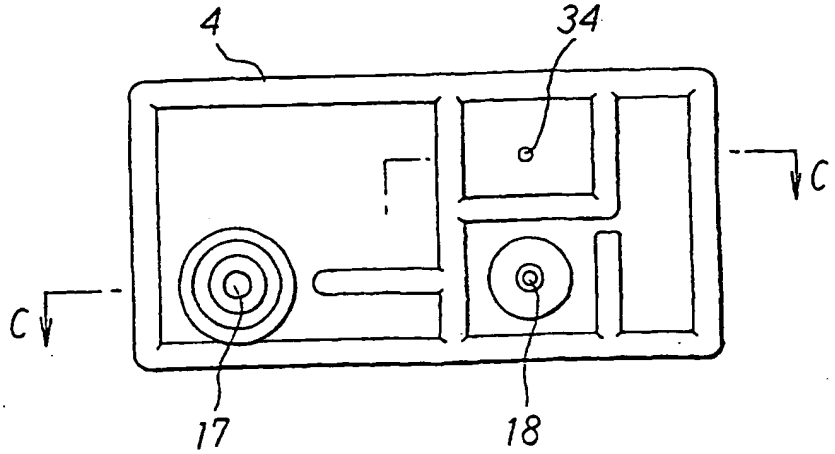


Fig. 10

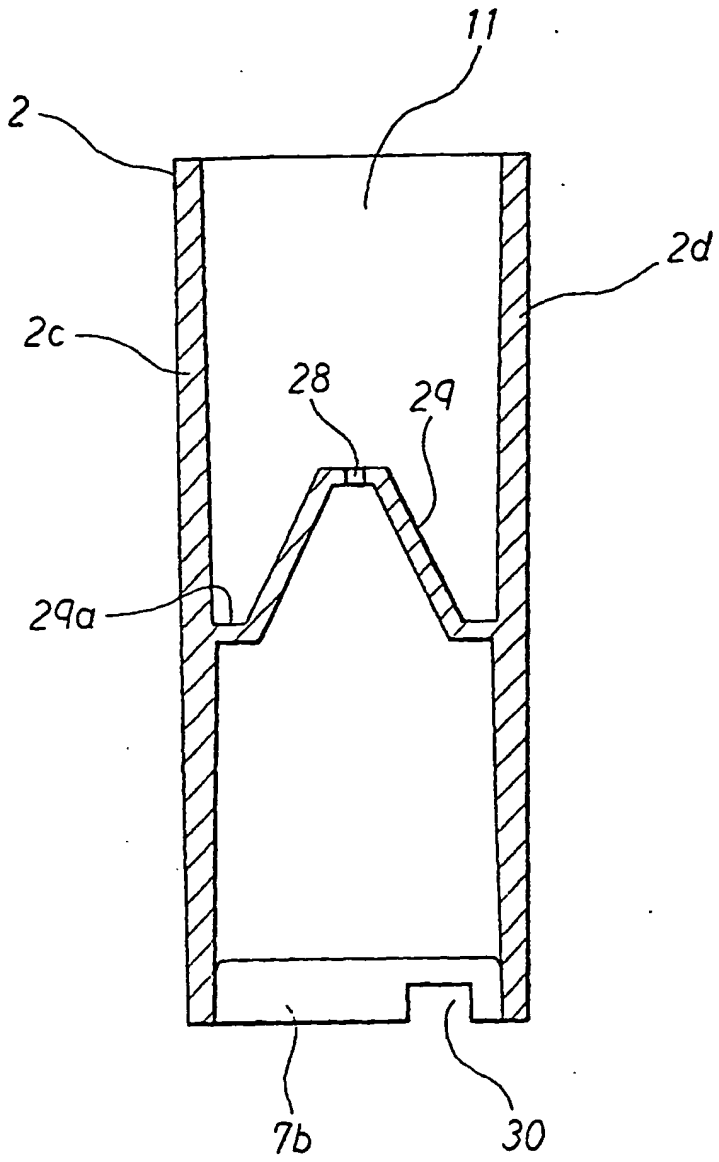


Fig. 11

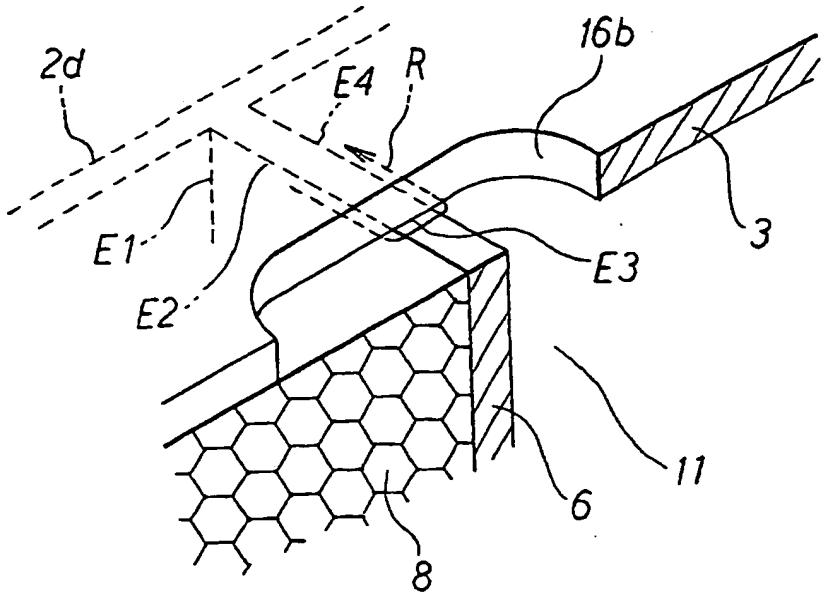


Fig. 12

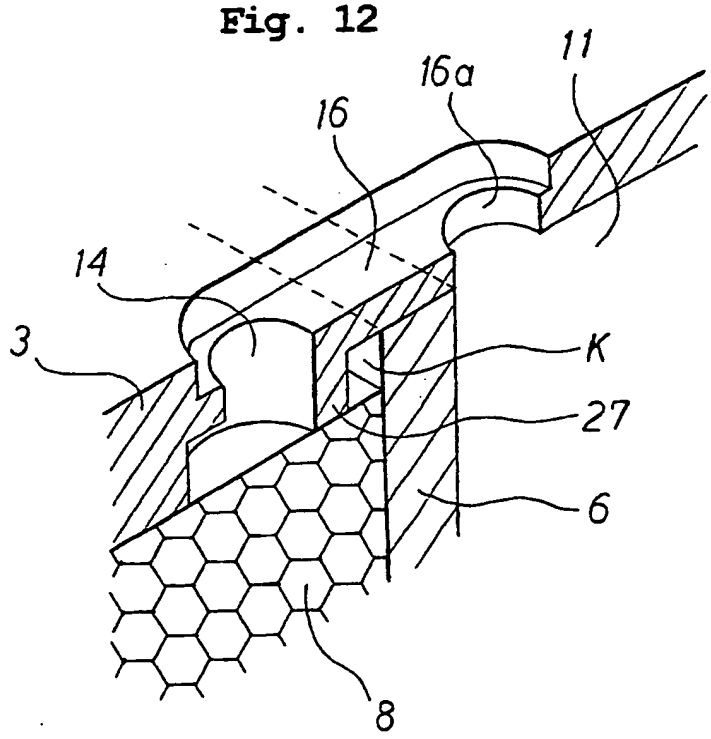


Fig. 13

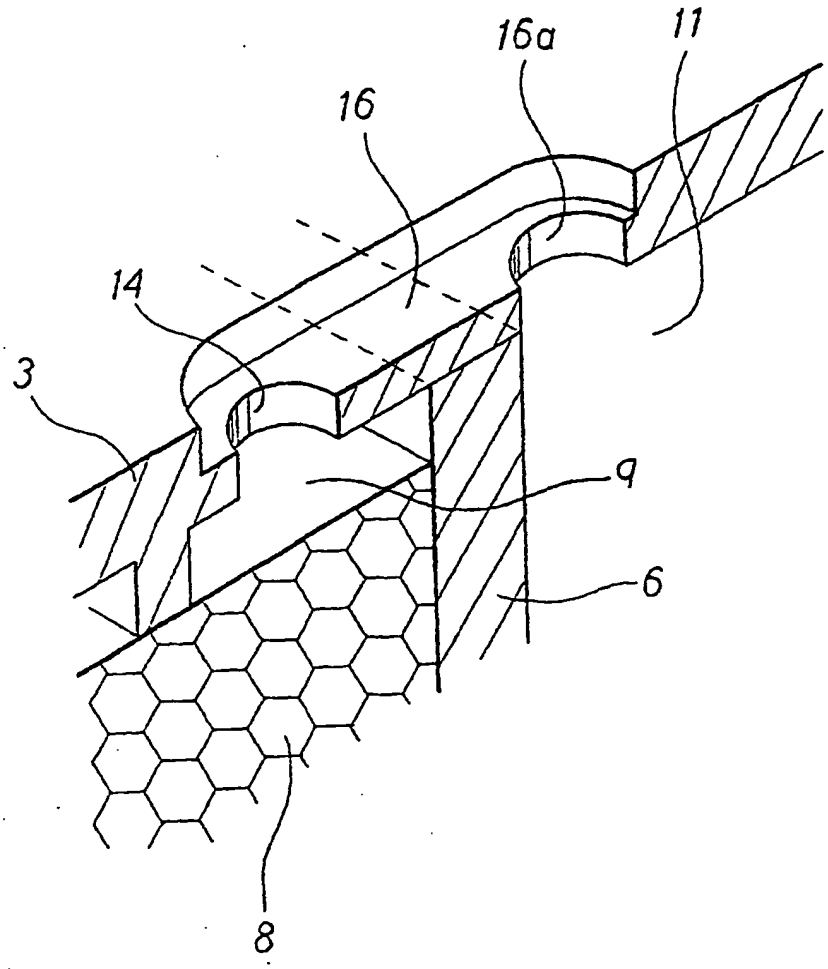


Fig. 14

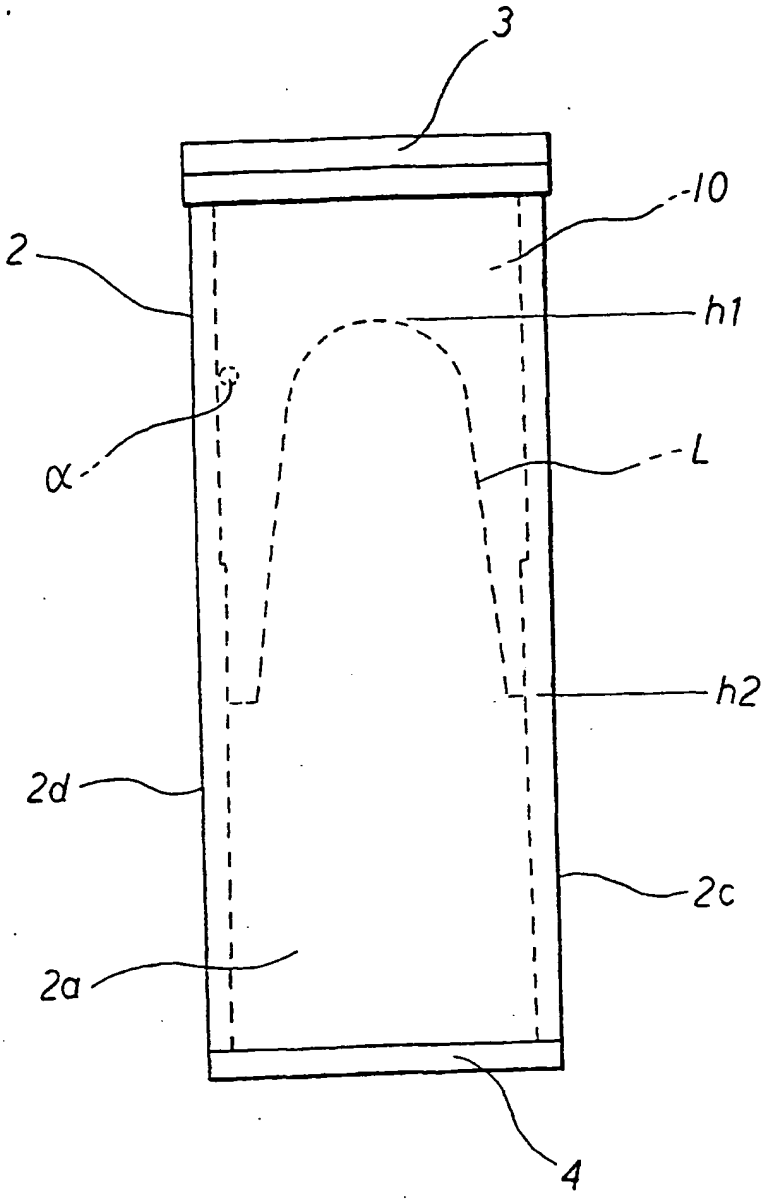


Fig. 15

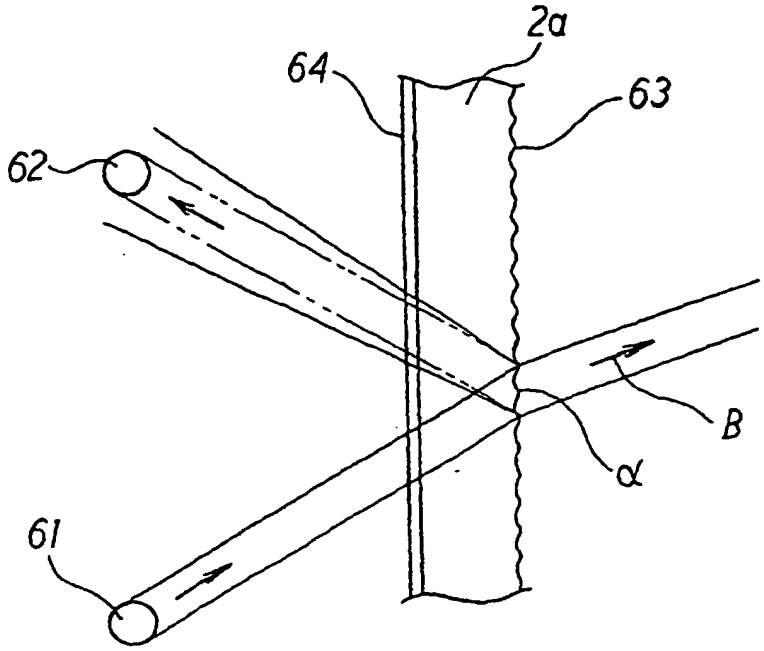


Fig. 16

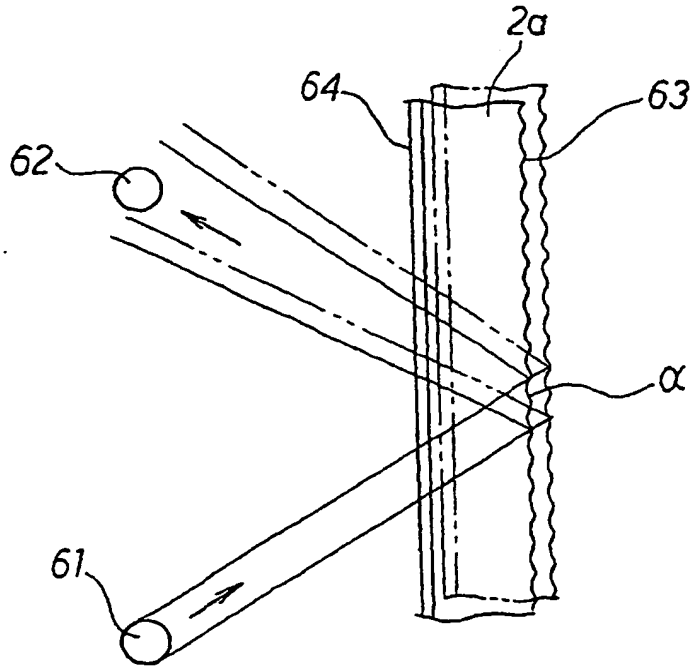


Fig. 17

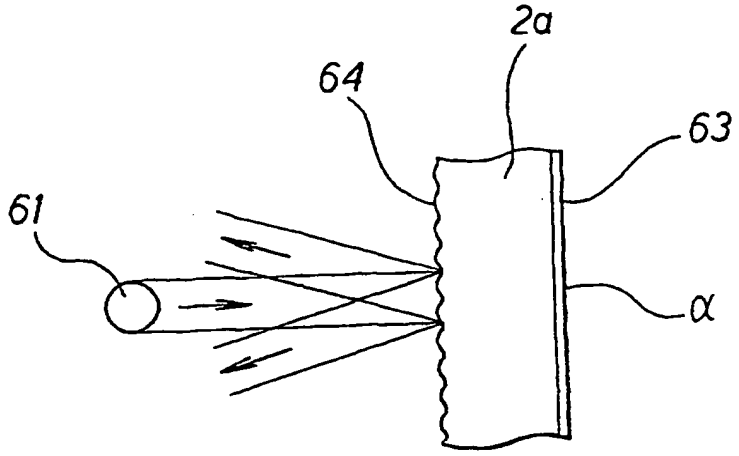


Fig. 18

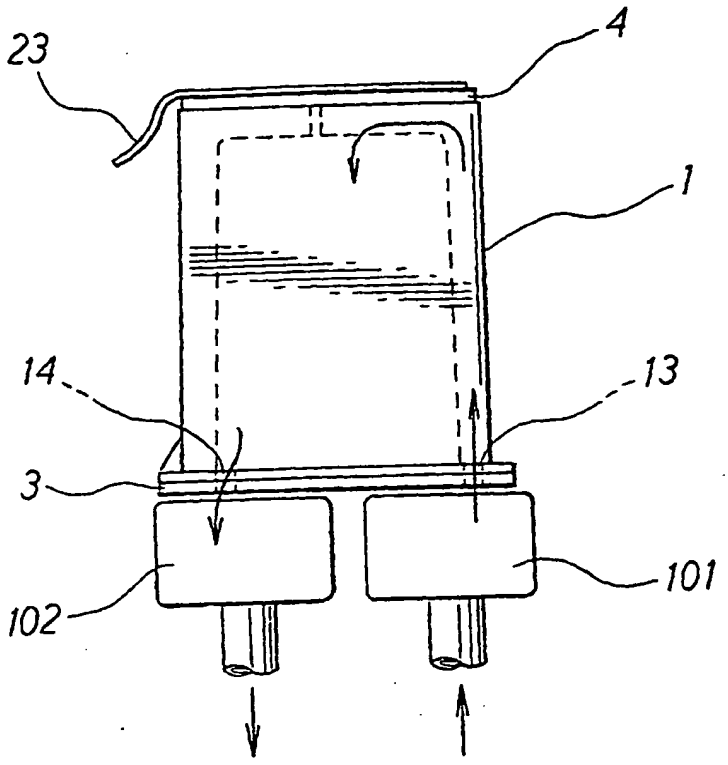
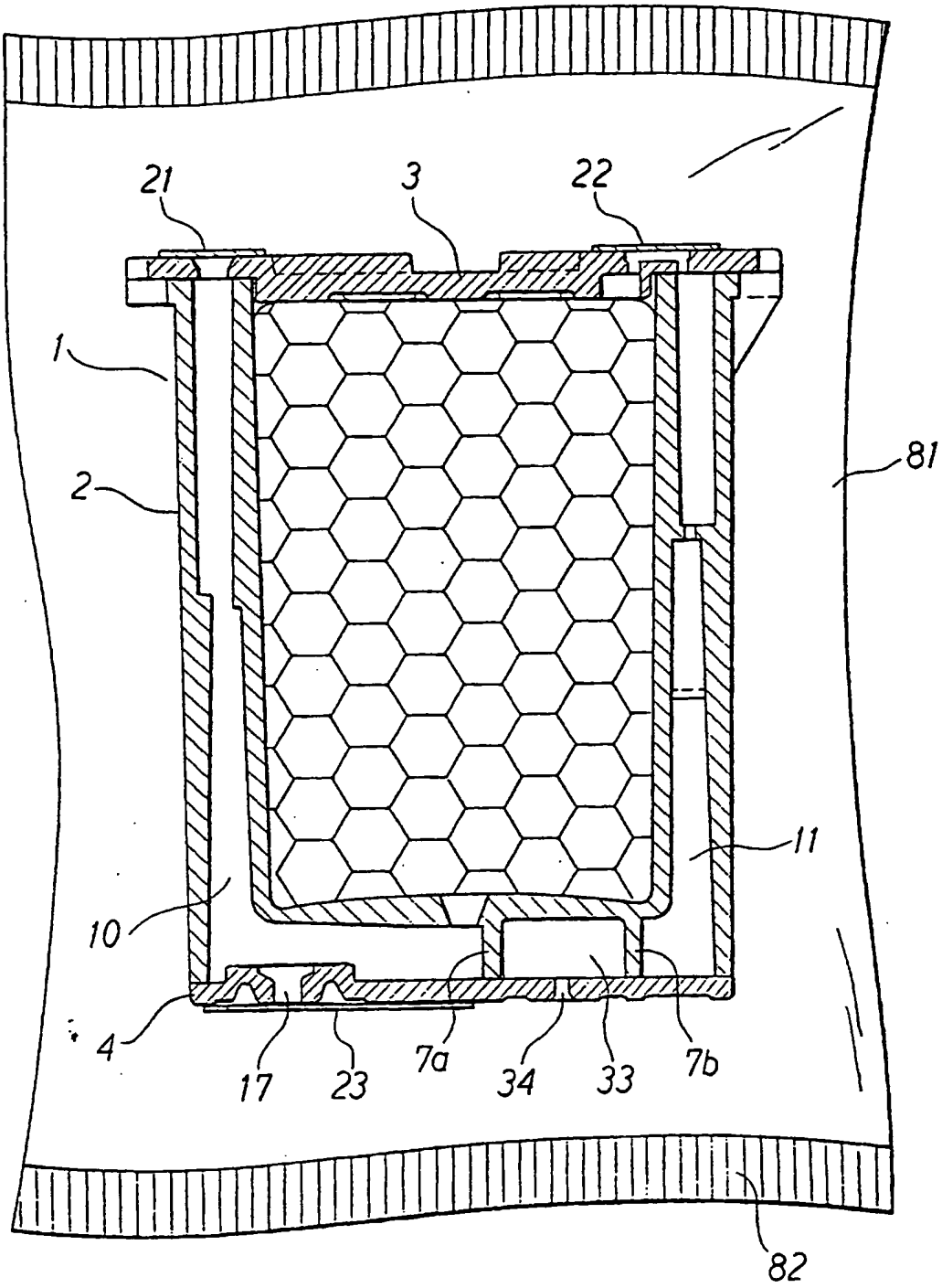


Fig. 19



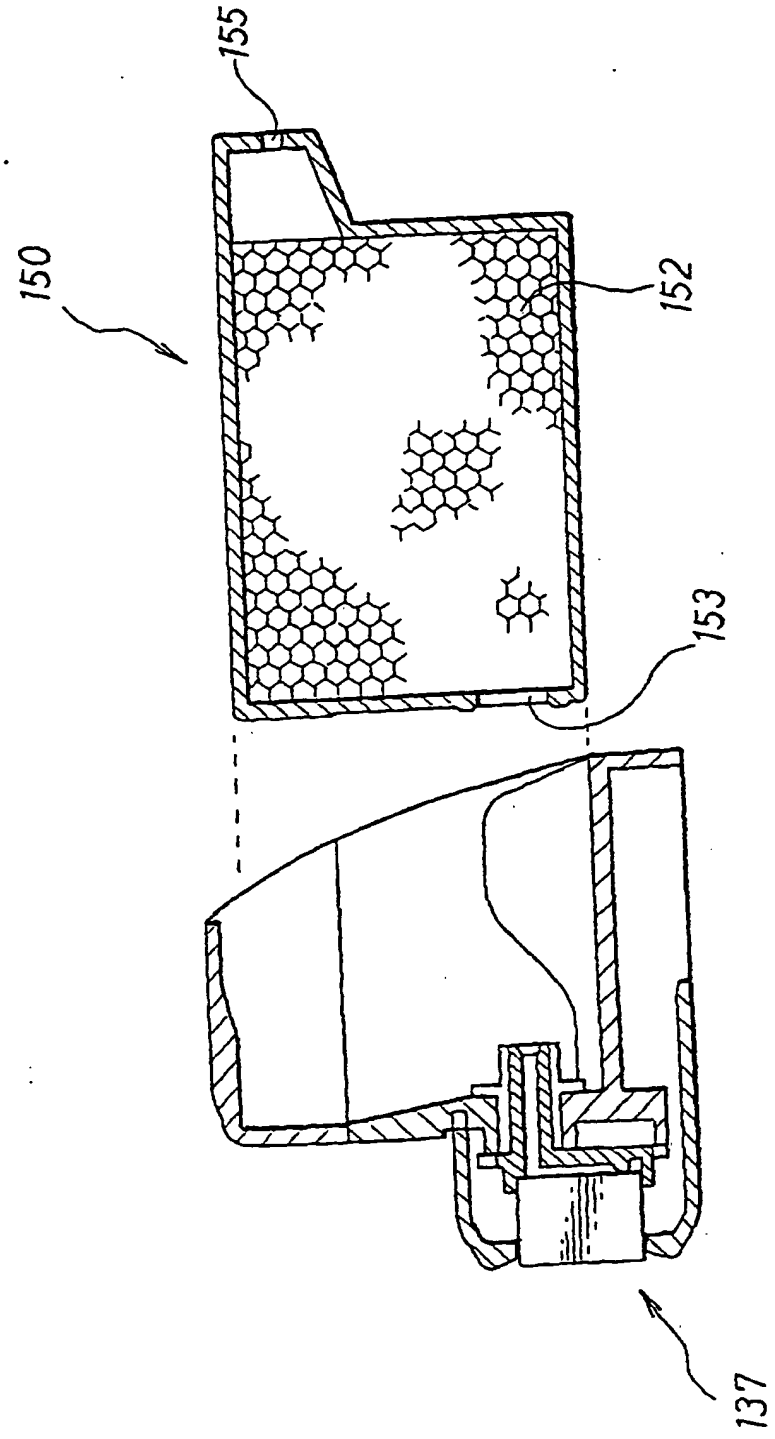


Fig. 20